

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(NASA-SP-7037(321)) AERONAUTICAL
ENGINEERING: A CONTINUING
BIBLIOGRAPHY WITH INDEXES
(SUPPLEMENT 321) (NASA) 173 p

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NASA SP-7037 (321)
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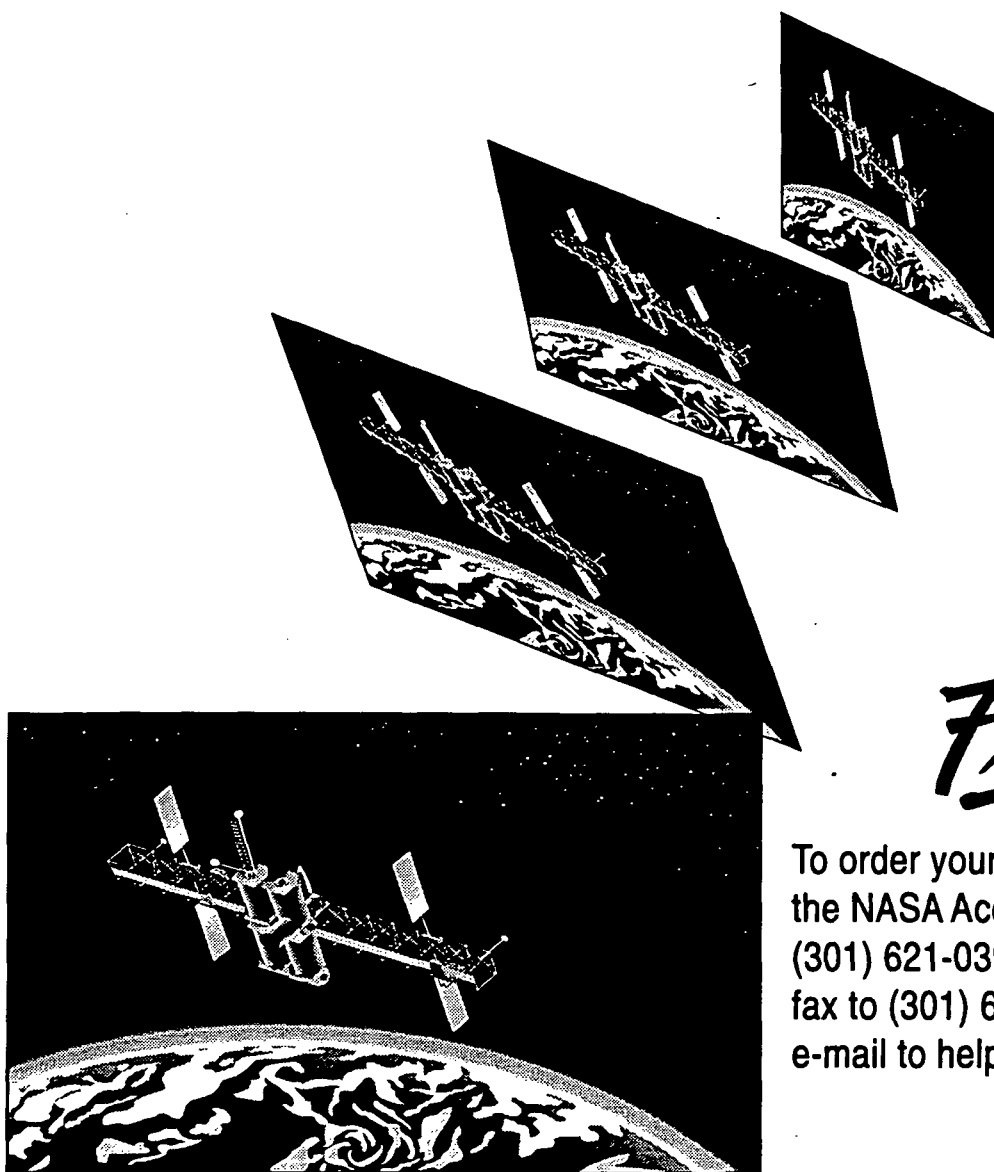
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INTRODUCTION

This issue of *Aeronautical Engineering — A Continuing Bibliography with Indexes* (NASA SP-7037) lists 496 reports, journal articles, and other documents recently announced in the NASA STI Database.

Accession numbers cited in this issue include:

Scientific and Technical Aerospace Reports (STAR) (N-10000 Series)
Open Literature (A-60000 Series)

N95-26342 — N95-28677
A95-82074 — A95-86771

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the publication consists of a standard bibliographic citation accompanied, in most cases, by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals.

Seven indexes—subject, personal author, corporate source, foreign technology, contract number, report number, and accession number—are included.

A cumulative index for 1995 will be published in early 1996.

The NASA CASI price code table, addresses of organizations, and document availability information are located at the back of this issue.



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TABLE OF CONTENTS

Category 01	Aeronautics	365
Category 02	Aerodynamics Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.	368
Category 03	Air Transportation and Safety Includes passenger and cargo air transport operations; and aircraft accidents.	379
Category 04	Aircraft Communications and Navigation Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.	382
Category 05	Aircraft Design, Testing and Performance Includes aircraft simulation technology.	384
Category 06	Aircraft Instrumentation Includes cockpit and cabin display devices; and flight instruments.	401
Category 07	Aircraft Propulsion and Power Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.	402
Category 08	Aircraft Stability and Control Includes aircraft handling qualities; piloting; flight controls; and autopilots.	407
Category 09	Research and Support Facilities (Air) Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.	410
Category 10	Astronautics Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications, spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.	412
Category 11	Chemistry and Materials Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; propellants and fuels; and materials processing.	416
Category 12	Engineering Includes engineering (general); communications and radar; electronics and electri- cal engineering; fluid mechanics and heat transfer; instrumentation and photogra- phy; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.	427

Category 13	Geosciences	442
	Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.	
Category 14	Life Sciences	N.A.
	Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.	
Category 15	Mathematical and Computer Sciences	447
	Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.	
Category 16	Physics	450
	Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.	
Category 17	Social Sciences	452
	Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.	
Category 18	Space Sciences	453
	Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.	
Category 19	General	453
Subject Index		A-1
Personal Author Index		B-1
Corporate Source Index.....		C-1
Foreign Technology Index.....		D-1
Contract Number Index		E-1
Report Number Index		F-1
Accession Number Index		G-1
Appendix		APP-1

TYPICAL REPORT CITATION AND ABSTRACT

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ACCESSION NUMBER → N95-10318*# Dow Chemical Co., Midland, MI. ← CORPORATE SOURCE

TITLE → NOVEL MATRIX RESINS FOR COMPOSITES FOR AIRCRAFT
PRIMARY STRUCTURES, PHASE 1 Final Report, Apr. 1989 -
Mar. 1992

AUTHORS → EDMUND P. WOO, P. M. PUCKETT, S. MAYNARD, M. T. BISHOP,
K. J. BRUZA, J. P. GODSCHALX, AND M. J. MULLINS Aug. 1992 ← PUBLICATION DATE
164 p

CONTRACT NUMBERS → (Contracts NAS1-18841; RTOP 510-02-11-02)

REPORT NUMBERS → (NASA-CR-189657; NAS 1.26:189657) Avail: CASI HCA08/MFA02 ← AVAILABILITY AND
PRICE CODE

The objective of the contract is the development of matrix resins with improved processability and properties for composites for primarily aircraft structures. To this end, several resins/systems were identified for subsonic and supersonic applications. For subsonic aircraft, a series of epoxy resins suitable for RTM and powder prepreg was shown to give composites with about 40 ksi compressive strength after impact (CAI) and 200 F/wet mechanical performance. For supersonic applications, a thermoplastic toughened cyanate prepreg system has demonstrated excellent resistance to heat aging at 360 F for 4000 hours, 40 ksi CAI and useful mechanical properties at greater than or equal to 310 F. An AB-BCB-maleimide resin was identified as a leading candidate for the HSCT. Composite panels fabricated by RTM show CAI of approximately 50 ksi, 350 F/wet performance and excellent retention of mechanical properties after aging at 400 F for 4000 hours. Author

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

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ACCESSION NUMBER → A95-60192* National Aeronautics and Space Administration. Ames ← CORPORATE SOURCE
Research Center, Moffett Field, CA.

TITLE → AERODYNAMIC INTERACTIONS BETWEEN A ROTOR AND
WING IN HOVER

AUTHORS → FORT F. FELKER NASA. Ames Research Center, Moffett Field, ← AUTHOR'S AFFILIATION
CA, US and JEFFREY S. LIGHT NASA. Ames Research Center,
Moffett Field, CA, US Journal of the American Helicopter Society ← JOURNAL TITLE

PUBLICATION DATE → 2 Jun. 1986 p. 53-61

REPORT NUMBER → (HTN-94-00714) Copyright

An experimental investigation of rotor/wing aerodynamic interactions in hover is described. The investigation consisted of both a large-scale and a small-scale test. A 0.658-scale V-22 rotor and wing was used in the large-scale test. Wing download, wing surface pressure, rotor performance, and rotor downwash data from the large-scale test are presented. A small-scale experiment was conducted to determine how changes in the rotor/wing geometry affected the aerodynamic interactions. These geometry variations included the distance between the rotor and wing, wing incidence angle, wing flap angle, rotor rotation direction, and configurations both with the rotor axis at the tip of the wing (tilt rotor configuration) and with the rotor axis at the center of the wing (compound helicopter configuration). Author (Hemer)

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 321)

September 1995

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AERONAUTICS (GENERAL)

A95-82224

DIRECT BOUNDARY INTEGRAL EQUATIONS METHOD TO SUBSONIC FLOW WITH CIRCULATION PAST THIN AIRFOILS IN GROUND EFFECT

LAZAR DRAGOS Univ of Bucharest, Bucharest, Romania and
ADRIAN DINU Computer Methods in Applied Mechanics and
Engineering (ISSN 0045-7825) vol. 121, no. 1-4 March 1995 p.
163-176 refs

(BTN-95-EIX95242673940) Copyright

A direct method for solving the problem of subsonic flow past a lifting or nonlifting airfoil in ground effects is presented. The problem is formulated in terms of velocity and it does not make use of the potential or the stream function. The nonlinear boundary condition is used. In this way, the solution is exact in the incompressible case for any shape of the airfoil (not necessarily thin). For the compressible case, we use linear equations of motion and the solution will be valid for thin airfoils. A set of Green functions that satisfies the boundary condition on the ground are deduced and an integral equation on the airfoil only is constructed. We solve the integral equation by means of a collocation method. The circulation is introduced as a parameter of the problem and it is related to the Kutta condition. The equal-pressure Kutta condition is used but the problem remains linear due to the formulation in velocities. In the incompressible case the solution for the circular body is compared with the exact solution, the coincidence being almost perfect. The other numerical experiments designed for the lifting profile NACA-4412 enlighten the compressibility and ground effects. Author (EI)

A95-85353

AUTOMATIC RIVETING CELL FOR COMMERCIAL AIRCRAFT FLOOR GRID ASSEMBLY

NIGEL R. ROCHE Deutsche Aerospace Airbus, Germany Aerospace Engineering (ISSN 0736-2536) vol. 15, no. 1 January-February 1995 p. 7-10

(HTN-95-92309) Copyright

An automatic riveting cell has been developed to permit the assembly of Airbus widebody aircraft floor grids as part of the Airbus manufacturing process. The cell contains six transportable multi-tooling fixtures, a magazine for storing the fixtures, an overhead crane for fixture transportation, two manufacturing stations, a robotic drill and riveting station, and a control center. This paper provides engineering drawings of the cell and the riveting tool, as well as a description of the cell's operation. This riveting cell has demonstrated its value by increasing the efficiency of Airbus A330/A340 production as customer design variations increase. Hemer

A95-85354

MAINTENANCE PROGRAMS

LINDA E. TREGO, ROGER SKINNER, KEN HYLANDER, BRUCE AUBIN, BILL HEINZE, TOM MORAN, SHERRY BERGSTROM, and ENNY ILIAKOPOULOU Aerospace Engineering (ISSN 0736-2536) vol. 15, no. 1 January-February 1995 p. 15-20

(HTN-95-92310) Copyright

Although maintenance programs vary among airlines and for different aircraft, the same basic maintenance requirements apply to all. This paper provides an overview of basic maintenance requirements and programs, and describes how maintenance programs are planned. Out-of-service and in-service maintenance are discussed. An example of typical system service forms, preflight checklist for in-service maintenance, turnaround/overnight checklist for in-service maintenance, as well as typical maintenance program are presented. Airline maintenance capabilities and maintenance centers are also described. Hemer

A95-85355

AIRCRAFT STRIPPING AND PAINTING

STUART BIRCH and LINDA E. TREGO Aerospace Engineering (ISSN 0736-2536) vol. 15, no. 1 January-February 1995 p. 21-23
(HTN-95-92311) Copyright

Researchers are examining various stripping processes and paints that will enhance coating life, reduce maintenance time, and be environmentally friendly. This paper describes these processes and paints, as well as a large aircraft robotic paint stripping system. Hemer

A95-85468

PREDICTING STALL AND POST-STALL BEHAVIOR OF AIRFOILS AT LOW MACH NUMBERS

TUNCER CEBECI California State Univ, Long Beach, CA, United States, HAMID HEFAZI, and FARZAM ROKNALDIN AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 595-602 refs
(BTN-95-EIX95262694297) Copyright

An interactive boundary-layer method, in conjunction an ϵ (sup n) approach for the calculation of onset of transition, was used in the prediction of stall and post-stall behavior of airfoils in compressible and incompressible flows at low freestream Mach numbers. Comparison of calculated results with the inviscid, incompressible flow calculated by panel method indicated excellent agreement for a wide range of Reynold numbers. In the case of compressible flow, comparison of the calculated results with that of the inviscid flow computed by full potential method also indicated excellent agreement for a wide range of angles of attack. Although compressibility corrections to the panel method were adequate at small-to-moderate angles of attack, they proved to be unsatisfactory at higher angles of attack. EI

A95-85482

MATRIX FRACTION APPROACH FOR FINITE-STATE AERODYNAMIC MODELING

L. MORINO Terza Università di Roma, Rome, Italy, F. MASTRODDI, R. DE TROIA, G. L. GHIRINGHELLI, and P. MANTEGAZZA AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 703-711 refs
(BTN-95-EIX95262694311) Copyright

A least-square procedure for the finite-state approximation of the aerodynamic matrix is introduced, which is more efficient and/or simpler to use than those currently available. This is accomplished by starting from the approximation of the aerodynamic matrix as $ND(\text{sup } -1)$ or $D(\text{sup } -1)N$, where N and D are matrices with

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polynomial dependence on complex reduced frequency p . Three different finite-state realizations based on the same matrix polynomial approximation are presented. The advantages of the approach and problems encountered in using the method are discussed. Numerical results are included. Author (EI)

A95-85484

STRESS CONSIDERATIONS IN REDUCED-SIZE AEROELASTIC OPTIMIZATION

M. KARPEL Technion - Israel Inst of Technology, Haifa, Israel and L. BRAININ AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 716-722 refs (BTN-95-EIX95262694313) Copyright

The modal approach, which is normally used in analysis and optimization with dynamic aeroelastic considerations, is extended here to deal with static aeroelastic maneuver trim equations, loads, and stresses. Reduced-size static equilibrium equations, where a subset of low-frequency vibration modes of a baseline structure is used as generalized coordinates, are formulated such that they can be used for modified structures without changing the coordinates. These expressions and their derivatives with respect to structural design variables are investigated in comparison with full-size finite element solutions. A new method, which uses modal stress perturbations of the baseline structure to predict stresses in the modified ones, is developed. The modal perturbation approach facilitates high-accuracy computations of stress sensitivities without increasing the model size. The presented formulation facilitates an efficient inclusion of stress and load considerations in on-line aeroservoelastic optimal design schemes. Author (EI)

A95-85492

COMPUTATIONAL ANALYSIS OF BUFFET ALLEVIATION IN VISCOUS TRANSONIC FLOW OVER A POROUS AIRFOIL

MARK A. GILLAN Short Brothers, Belfast, United Kingdom AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 769-772 refs (BTN-95-EIX95262694321) Copyright

An explicit finite volume cell-vertex-centered Navier-Stokes solver, in conjunction with an orthogonal boundary conforming hydrobolic C-grid generator, was used for computing the time-accurate flow over an 18%-thick porous circular-arc airfoil in order to ascertain effect of passive control (eg. damping or elimination of flow periodicity) on periodic transonic viscous flow. Navier-Stokes solver demonstrated the ability of passive control to suppress Tijdeman-type-B SIO leading to buffeting. EI

N95-26363*# Purdue Univ., West Lafayette, IN. WINCLR: A COMPUTER CODE FOR HEAT TRANSFER AND CLEARANCE CALCULATION IN A COMPRESSOR

T. K. BOSE and S. N. B. MURTHY Jun. 1994 170 p (Contract(s)/Grant(s): NAG3-481; RTOP 505-62-52; DTFA03-83-A-00328) (NASA-CR-195436; E-9461; NAS 1.26:195436; DOT/FAA/CT-TN94-61; M/NAFA/94-1) Avail: CASI HC A08/MF A02

One of the concerns during inclement weather operation of aircraft in rain and hail storm conditions is the nature and extent of changes in compressor casing clearance. An increase in clearance affects efficiency while a decrease may cause blade rubbing with the casing. The change in clearance is the result of geometrical dimensional changes in the blades, the casing and the rotor due to heat transfer between those parts and the two-phase working fluid. The heat transfer interacts nonlinearly with the performance of the compressor, and, therefore, the determination of clearance changes necessitates a simultaneous determination of change in performance of the compressor. A computer code the WINCLR has been designed for the determination of casing clearance, that is operated interactively with the PURDU-WINCOF I code designed previously for determining the performance of a compressor. A detailed description of the WINCLR code is provided in a companion report. The current report provides details of the code with an illustrative example of application to the case of a multistage compressor. It is

found in the example case that under given ingestion and operational conditions, it is possible for a compressor to undergo changes in performance in the front stages and rubbing in the back stages.

Author

N95-26381*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

FLUTTER CLEARANCE FLIGHT TESTS OF AN OV-10A AIRPLANE MODIFIED FOR WAKE VORTEX FLIGHT EXPERIMENTS

ROBERT V. DOGGETT, JR., JOSE A. RIVERA, JR., and ERIC C. STEWART Apr. 1995 14 p (Contract(s)/Grant(s): RTOP 505-63-50-13) (NASA-TM-109168; NAS 1.15:109168) Avail: CASI HC A03/MF A01

The envelope expansion, flight flutter tests of a modified OV-10A aircraft are described. For the wake vortex research program, the airplane was modified to incorporate three forward-extending instrumentation booms, one extending forward from each wing tip and one from the right side of the fuselage. The booms were instrumented with sensors to measure the velocity and direction of local air flow. The flutter test results show that the modified OV-10A aircraft is free from flutter at speeds up to 330 KEAS at 5000 feet altitude. Author

N95-26409 Industrial Coll. of the Armed Forces, Washington, DC. STRATEGY IN THE COMMERCIAL AIRCRAFT INDUSTRY IN THE UNITED STATES: A COMPARISON OF DECISIONMAKING BY MCDONNELL-DOUGLAS AND BOEING AIRCRAFT COMPANIES FROM 1977-1983

Research Report, Aug. 1993 - Apr. 1994 DAVE GILLET Apr. 1994 38 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A288289; NDU-ICAF-94-F2) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This paper studies strategic decision making in the commercial aircraft manufacturing market. It compares the decisions made by McDonnell-Douglas Corporation with those of Boeing Aircraft Company in the late 70s and early 80s. The study concludes that strategic decisions were made based on each companies vision of its core business. McDonnell-Douglas refused to risk its capital on a new commercial aircraft because its core business was defense. Boeing on the other hand was willing to risk the company on new aircraft development because its core business was the commercial aircraft market. DTIC

N95-26455 Industrial Coll. of the Armed Forces, Washington, DC. SURVIVING THE PEACE. LESSONS LEARNED FROM THE AIRCRAFT INDUSTRY IN THE 1920S AND 1930S

Report, Aug. 1993 - Apr. 1994 ELLEN M. PAWLKOWSKI Apr. 1994 39 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A288284; NDU-ICAF-94-F56) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Many of America's defense industries are struggling to survive in today's peacetime environment. As they prepare for the future, US business and government leaders can learn from defense industries that survived the last extended peace. This paper examines the American aircraft industry during the peace from 1920 to 1939. During that time, the industry retained core capability for future defense needs while establishing alternative markets for its products. They succeeded because they placed a strong emphasis on broad based R&D and conducted a concerted effort to establish alternative markets. Industry and national leaders used those alternative markets to strengthen the industry and the national economy. The federal government supported industry efforts by funding research and development, establishing a national aviation infrastructure, and opening foreign markets. The Congress also funded military aircraft production that helped the industry weather market downturns. Although commercial markets existed, aircraft manufac-

turers failed to achieve independence from government contracts. This failure was due to government procurement practices, poor business management by aviation pioneers, the high cost of technology development, and the small size of commercial markets. Today's defense industries should study the lessons of the aircraft manufacturers as they determine business strategy for the 1990s. The federal government can also apply these lessons as it makes decisions regarding research investments, military-commercial integration, acquisition reform, and export policies. We can never repeat history, but we can learn from it. By studying the lessons of the last extended peace, perhaps we can avoid the mistakes and duplicate the successes. DTIC

N95-26629 Battelle Memorial Inst., Columbus, OH.
DEVELOPMENT OF REPAIR PROCESSES AND SOURCES FOR C/KC-135 AIRCRAFT WINDOWS/WINDSHIELDS Final Technical Report, 1 Sep. 1991 - 31 Jan. 1994
RICHARD J. OLSON Sep. 1994 521 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): F09603-90-D-2217)
(AD-A288348) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The U.S. Air Force has historically rejected the notion of using repaired windows/windshields (W/WS). With increasing pressure to reduce fleet operating costs and based on the favorable experience that commercial fleets have had, interest in using repaired W/WS is receiving greater attention. To ensure that repaired W/WS are safe and that they provide similar benefits for the Air Force, a program of evaluation and testing was undertaken to compare new and repaired C/KC-135 W/WS. Optical and electrical properties, pressure integrity, and bird impact resistance of repaired and new W/WS have been evaluated. The bird impact test results are the first data that the Air Force have collected for C/KC-135 W/WS. The functional testing indicated that repaired W/WS are not equal to new W/WS; the new W/WS outperform the repaired W/WS. However, in terms of removal for cause criteria and absolute performance requirements, the repaired W/WS appear to be good enough. Concerning costs, the direct costs for repair of the W/WS in this program ranged from 65-75% of new W/WS cost, suggesting that money can be saved. DTIC

N95-26710* Army Aviation Systems Command, Hampton, VA.
DEVELOPMENT AND VALIDATION OF A BLADE-ELEMENT MATHEMATICAL MODEL FOR THE AH-64A APACHE HELICOPTER
M. HOSSEIN MANSUR Apr. 1995 98 p
(Contract(s)/Grant(s): RTOP 505-59-36)
(NASA-TM-108863; A-95034; NAS 1.15:108863; USAATCOM-TR-94-A-022) Avail: CASI HC A05/MF A02

A high-fidelity blade-element mathematical model for the AH-64A Apache Advanced Attack Helicopter has been developed by the Aeroflightdynamics Directorate of the U.S. Army's Aviation and Troop Command (ATCOM) at Ames Research Center. The model is based on the McDonnell Douglas Helicopter Systems' (MDHS) Fly Real Time (FLYRT) model of the AH-64A (acquired under contract) which was modified in-house and augmented with a blade-element-type main-rotor module. This report describes, in detail, the development of the rotor module, and presents some results of an extensive validation effort. Author

N95-26817# General Accounting Office, Washington, DC. National Security and International Affairs Div.
ASIAN AERONAUTICS: TECHNOLOGY ACQUISITION DRIVES INDUSTRY DEVELOPMENT. REPORT TO CONGRESSIONAL REQUESTERS
4 May 1994 19 p
(GAO/NSIAD-94-140; B-256707) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20884-6015 HC
This report responds to a request to review the aeronautics

research and development (R&D) activities of Asian countries. More specifically, we are providing information on (1) the approaches these Asian nations use to develop their aeronautics industries, (2) the level of aeronautics development each country has achieved, and (3) the implications of this development for the U.S. aeronautics industry. This report represents an amalgamation of many pieces of data obtained from dozens of U.S. and foreign sources. However, because of the nature of much of the data, we were unable to verify its accuracy or make an independent assessment of the extent and progress of each country's R&D efforts. Derived from text

N95-26941# Wichita State Univ., Wichita, KS. National Inst. for Aviation Research.

AIAA TECHFEST 20 PROCEEDINGS

WILLIAM H. WENTZ, ed. 1994 275 p Techfest held in Wichita, KS, 12-13 Nov. 1993

(NIA9-94-1) Avail: CASI HC A12/MF A03

A wide range of topics concerned with aerodynamics and design considerations is addressed. Also addressed are structures-related topics and the manufacturing considerations associated with the designing of a high altitude long endurance aircraft. The airspace database is discussed, as well as the results and capabilities of a new jet facility at the University of Kansas. As part of miscellaneous topics, prevention and control of inlet unstart using an SR-71 simulation is presented, along with an easy way to analyze longitudinal and lateral-directional trim problems with AEO or OEI. For individual titles, see N95-26942 through N95-26956.

N95-26948# Kansas Univ., Lawrence, KS.

PREVENTION AND CONTROL OF INLET UNSTART USING AN SR-71 SIMULATION Abstract Only

TROY DOWNEN In Wichita State Univ., AIAA Techfest 20 Proceedings 1 p 1994

Avail: CASI HC A01/MF A03

The effect of inlet unstart — a major concern in the development of a next generation high speed civil transport, — is addressed. The University of Kansas' presentation pertaining to the problems associated with the inlet unstart is outlined. Derived from text

N95-26952* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH. Sverdrup Technology.
VISUALIZATION OF THE MULTIPLE SUPERSONIC JET OSCILLATIONS BY SWEEPED FOCUSED STROBED SCHLIEREN TECHNIQUE

GANESH RAMAN and RAY TAGHAVI (Kansas Univ., Lawrence, KS.) In Wichita State Univ., AIAA Techfest 20 Proceedings 8 p 1994

Avail: CASI HC A02/MF A03

The natural flapping mode oscillations of a multiple rectangular supersonic jet is visualized by the newly developed strobed focusing schlieren technique. Four parallel underexpanded, converging rectangular jets, exhausting into ambient air at a fully expanded Mach number of 1.61 are visualized in this study. This technique clearly shows the oscillations at the natural screech frequency and offers tremendous flexibility in the study of these flow fields. Author

N95-27543* National Aeronautics and Space Administration, Washington, DC.

AERONAUTICAL ENGINEERING: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 318)

Jun. 1995 93 p
(NASA-SP-7037(318); NAS 1.21:7037(318)) Avail: CASI HC A05

This bibliography lists 217 reports, articles, and other documents introduced into the NASA scientific and technical information system in June 1995. Subject coverage includes: design, construction and testing of aircraft and aircraft engines; aircraft components, equipment, and systems; ground support systems; and theoretical and applied aspects of aerodynamics and general fluid dynamics. Author

01 AERONAUTICS (GENERAL)

N95-28610 American Inst. of Aeronautics and Astronautics, Washington, DC.

PROCEEDINGS OF THE AIAA/FAA JOINT SYMPOSIUM ON GENERAL AVIATION SYSTEMS Final Report

GUS FERRARA and ROBERTO DIMICHELE Sep. 1994 627 p Symposium held in Starkville, MS, 24-25 May 1994 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(AD-A289830; DOT/FAA/CT-94/63) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The 1994 AIAA/FAA Joint Symposium on General Aviation Systems was the result of the combined efforts of the AIAA General Aviation Systems Technical Committee and the Federal Aviation Administration Technical Center. This symposium offered the opportunity to present and review the current state of the art in research that is being conducted in support of general aviation. All told, the papers presented covered the entire spectrum of research, and the participants had the opportunity to hear presentations on everything from alternate fuels to developments in air traffic control. DTIC

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

A95-82413

NAL AEROTHERMODYNAMIC PROBING AND CFD VERIFICATION MISSION IN OREX EXPERIMENT

YASUTOSHI INOUE National Aerospace Laboratory, Tokyo, Japan, YASUO WATANABE National Aerospace Laboratory, Tokyo, Japan, YASUHIRO WADA National Aerospace Laboratory, Tokyo, Japan, TOSHIO AKIMOTO National Space Development Agency, Ibaraki, Japan, and HIDEMI YASUI Nissan Motor Company, Ltd., Tokyo, Japan /In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 781-786

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An experiment is planned by National Space Development Agency (NASDA) with the first Japanese reentry capsule from orbit as one of payloads of H-II rocket at its first test flight in February 1993. In this experiment, called OREX (Orbital Reentry Experiment), the National Aerospace Laboratory (NAL) carries out the aerothermodynamic measurements mission related to the dissociation ionization caused by high temperature and the rarefied gas state. The aerothermodynamic and thermochemical data are not only mission objectives in themselves but are used to verify the computational fluid dynamics (CFD) codes by comparing them with results of CFD simulation newly-developed at the National Aerospace Laboratory (NAL). The CFD in this mission plays very important double roles: to develop sensors and apparatus and to make itself as reliable design tools for HOPE and future space planes through the flight verification. Full Navier-Stokes codes dealing with the dissociation ionization of air and the DSMC code for rarefied aerodynamic characteristics are being developed and tested by the NAL Numerical Simulator System. CFD codes and the onboard sensors have been developed through ground testing. The 450kW arc-heated wind tunnel at NAL is extensively operated to determine the specifications of and to confirm the characteristics of sensors like the electrostatic probe and atomic recombination heating sensors. Various tests have been conducted using relevant facilities. Development status of sensors/probes and some results of tests and calculations are described. Author (Hemer)

A95-82421

AN EXPERIMENTAL STUDY ON RADIATION FROM STRONG SHOCK LAYER

XIN-YU CHANG Nagoya University, Nagoya, Japan, MAKOTO HEMMI Nagoya University, Nagoya, Japan, AKIHIRO SASOH Tohoku University, Sendai, Japan, and TOSHI FUJIWARA Nagoya University, Nagoya, Japan /In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 831-836

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A small plastic projectile is accelerated up to higher than 5 km/sec by a ballistic range apparatus in the present study. A spectral measurement is done when the projectile passes through the test section, emitting radiation from its strong shock layer. It is found from the obtained data that the radiative chemical species are N₂ with respect to its positive and second positive bands and several CN violet bands. In order to study the emission with high time-resolution, a high-speed shutter system using an image intensifier and a pulse generator is set up. Using this system, a two-dimensional spatial distribution of radiation intensity in the shock layer is obtained. Another measurement to take framing pictures of the projectile during its flight is also performed. These measurements tell us that such systems can be used in the study of reentry problems in laboratory environment after future improvement of the ballistic range performance. For this purpose, a metallic projectile must be employed instead of plastic ones in the next stage, because the photographs taken by a high-speed camera show that the critical limit of destruction for the projectile material would be reached when the projectile velocity exceeds 5 km/sec. Author (Hemer)

A95-82513

POLAR PATROL BALLOON SYSTEM AND PRELIMINARY EXPERIMENTAL RESULTS

T. HIRASAWA National Inst. of Polar Research, Tokyo, Japan, M. EJIRI National Inst. of Polar Research, Tokyo, Japan, R. FUJII National Inst. of Polar Research, Tokyo, Japan, A. KADOKURA National Inst. of Polar Research, Tokyo, Japan, J. NISHIMURA Kanagawa Univ., Kanagawa, Japan, N. YAJIMA Inst. of Space and Astronautical Science, Kanagawa, Japan, M. AKIYAMA Inst. of Space and Astronautical Science, Kanagawa, Japan, T. YAMAGAMI Inst. of Space and Astronautical Science, Kanagawa, Japan, S. OHOTA Inst. of Space and Astronautical Science, Kanagawa, Japan, and S. KOKUBUN Univ. of Tokyo, Tokyo, Japan /In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 1473-1778

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In the polar region, there are a lot of interesting research areas. A balloon is a useful tool for the observations of such items. The Polar Patrol Balloon (PPB) project aims for a long distance and long duration circumpolar balloon flight at Antarctica. From December 1990 to September 1992, the National Institute of Polar Research conducted the PPB project in collaboration with the Institute of Space and Astronautical Science, and launched three large zero-pressure balloons from Syowa Station, which is the Japanese research base in Antarctica. The balloon launched on December 25 returned near Syowa Station after 15 days of flight, keeping a constant altitude of about 30 km. It finally accomplished almost one and a half circumpolar flights. Another two balloons also achieved long duration flights of more than one week and a long distance flight of more than halfway round of Antarctic Continent. This paper will describe the ground system for balloon launching and the flight behavior of the balloons. Author (Hemer)

A95-82669

HYPERSONIC FLOW SIMULATION WITH THERMOELECTRIC EFFECT

AKIRA URITA Nagoya Univ., Nagoya, Japan /In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 2465-2471

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In the reentry flow field, the shock wave in front of a spacecraft and the chemical reaction cause shock layer high temperature and high pressure, of which gas is partially ionized plasma (about 10000 K). According to Shebalin, in the shock layer (ionized layer), the thermoelectric field induces magnetic field, and the resulting current and Joule heating considerably increase, the electron temperature. Such changes of the electron temperature and density give large influences on radiative heat transfer, and they must be considered in design of the heat protection system of spacecraft such as the AOTV (Aeroassisted Orbital Transfer Vehicle). Spontaneous magnetic field generation due to the thermoelectric effect is known as thermal instability in a inertia confinement fusion field or as a battery effect in geophysics. As can be seen in the momentum equation for electrons, in the ionization layer, electric force is balanced with the electron pressure gradient. If a temperature gradient exists along the layer, the resulting curl of the electric field produces the magnetic field. A thermal and chemical nonequilibrium two dimensional calculation has already been performed for argon. This two dimensional code is extended to an axisymmetric one, and the calculation is executed around slab and hemisphere cylinder. These results are compared with each other, and differences between two dimensional and axisymmetric flows are studied. Author (Herner)

A95-83656
VORTEX METHODS FOR THE COMPUTATIONAL ANALYSIS OF ROTOR/BODY INTERACTION

T. R. QUACKENBUSH Continuum Dynamics, Inc., Princeton, NJ, US, C.-M. G. LAM Continuum Dynamics, Inc., Princeton, NJ, US, and D. B. BLISS Duke Univ., NC, US American Helicopter Society, Journal (ISSN 0002-8711) vol. 39, no. 4 October 1994 p. 14-24 Research sponsored by the U.S. Army Research Office (HTN-95-61072) Copyright

This paper describes the development and implementation of a unified model of rotorcraft interactional aerodynamics using advanced methods in vortex dynamics. The model incorporates several recently-developed tools for the analysis of vortex wake dynamics and vortex/surface interaction including: a Constant Vorticity Contour (CVC) full-span free wake model; a method for the prediction of surface pressures caused by close vortex interactions based on Analytical Numerical Matching (ANM); and a new analytical asymptotic analysis of curved vortex interaction with curved surfaces. The development of each of these features of the model is described as is their coupling with a panel method analysis of the fuselage. Model problems are solved to demonstrate the ability of the ANM model to predict inviscid vortex/surface interactions accurately and with greater efficiency and consistency than traditional methods. In addition, fundamental studies of curved filament dynamics near curved surfaces are described, along with correlations of measured and predicted surface pressures. Though the present analysis is limited to inviscid interactions, it nonetheless provides a useful predictive capability for certain classes of realistic wake/airframe interactions. Author (Herner)

A95-83657
ON THE INFLUENCE OF TIME-VARYING FLOW VELOCITY ON UNSTEADY AERODYNAMICS

B. G. VAN DER WALL Inst. for Flight Mechanics, Braunschweig, Germany and J. G. LEISHMAN Univ. of Maryland at College Park, College Park, MD, US American Helicopter Society, Journal (ISSN 0002-8711) vol. 39, no. 4 October 1994 p. 25-36 (HTN-95-61073) Copyright

The effects of a periodic free-stream velocity on the unsteady aerodynamics of an airfoil in incompressible flow are examined. Existing theories are reviewed, and their simplifications and limitations are properly identified. A new general aerodynamic theory for an airfoil undergoing a combination of harmonic pitching, plunging and fore-aft motion is presented. An extension to arbitrary free-stream velocity variations and arbitrary airfoil motion is also given. The theoretical results are validated against numerical predictions made by a modern Euler code. Author (Herner)

A95-83658
EFFECTS OF BLADE TIP SHAPE ON DYNAMICS, COST, WEIGHT, AERODYNAMIC PERFORMANCE, AND AEROELASTIC RESPONSE

JING G. YEN Bell Helicopter Textron, Inc., Fort Worth, TX, US American Helicopter Society, Journal (ISSN 0002-8711) vol. 39, no. 4 October 1994 p. 37-45 (HTN-95-61074) Copyright

Effects of a swept/tapered tip planform with a thin 6% tip airfoil on blade weight, cost, dynamic tuning, elastic twist, loads/vibration, and aerodynamic performance are compared with those of a rectangular tip on a four-bladed bearingless rotor using a comprehensive analysis. Validation of the analysis is conducted using wind tunnel data. The swept/tapered tip blade has a thrust-weighted chord identical with that of the rectangular planform and is dynamically tuned to match the flapping inertia and rotor dynamics of the rectangular tip blade. Results indicate that, in high-speed flight, the swept/tapered tip reduces pitch-link loads, blade beam bending, and 4/rev hub moments, but has insignificant effects on blade chord bending and aerodynamic performance. The penalties associated with the swept/tapered tip are a 5.4% increase in blade weight and a 5% to 12% increase in blade manufacturing cost. Effects of rotor solidity, airfoil thickness, tip speed, and blade torsional stiffness on the performance of a swept/tapered tip are also investigated and the results are reported. Author (Herner)

A95-83659
AIR RESONANCE OF HINGELESS ROTOR HELICOPTERS IN TRIMMED FORWARD FLIGHT

JUDAH H. MILGRAM Univ. of Maryland, College Park, MD, US and INDERJIT CHOPRA Univ. of Maryland, College Park, MD, US American Helicopter Society, Journal (ISSN 0002-8711) vol. 39, no. 4 October 1994 p. 46-58 (Contract(s)/Grant(s): DAAH04-93-G-0001) (HTN-95-61075) Copyright

Air resonance of a soft inplane hingeless rotor helicopter is examined in hover and forward flight using a simple model combining a rigid blade flap-lag model with body pitch and roll motions. Stability is calculated about a coupled rotor/body trim condition obtained using a finite element in-time approach for blade response and a force-summation method for hub loads. The linearized rotor-body stability equations are expressed in the fixed system using a multiblade coordinate transformation and solved via Floquet analysis. Predicted stability results correlate well with experimental data. Both shaft fixed flap-lag stability and air resonance stability improve in forward flight above an advance ratio of approximately 0.2. This is largely the result of changes in the vehicle trim solution. The effects of variations of several design parameters are investigated. For the configuration examined, air resonance stability varied with body roll inertia but was insensitive to pitch inertia. Variations in blade lag frequency had a considerable effect on stability, while the blade flap frequency had relatively less influence. Increasing Lock number decreased hover stability but had a strong stabilizing effect in forward flight. Author (Herner)

A95-83660
AN ANALYTICAL MODEL FOR A NONLINEAR ELASTOMERIC LAG DAMPER AND ITS EFFECT ON AEROMECHANICAL STABILITY IN HOVER

FARHAN GANDHI Univ. of Maryland, College Park, MD, US and INDERJIT CHOPRA Univ. of Maryland, College Park, MD, US American Helicopter Society, Journal (ISSN 0002-8711) vol. 39, no. 4 October 1994 p. 59-69 (Contract(s)/Grant(s): DAAH04-93-G-0001) (HTN-95-61076) Copyright

A new nonlinear elastomeric damper model, based on a combination of linear and nonlinear springs and dashpots, is developed. The damper is characterized completely by a nonlinear constitutive differential equation. Since this 'differential equation approach' is not based on the frequency- and amplitude-dependent complex modulus components, it can conveniently be used in a variety of

operating conditions, including multi-frequency excitations, varying rotor speeds, and different steady-lag angles. A methodology is developed for the inclusion of such a damper model into a rotor analysis scheme. For aeromechanical stability analysis, the damper perturbation equation is solved along with the blade and fuselage equations, with damper-force appearing as an independent state. The elastomeric damper has a stabilizing influence on ground resonance and hover air resonance regressive lag modes. The eigensolution damping estimates overpredict the damping when the system is subjected to larger perturbations. Steady lag angle as a significant influence on the elastomeric damper behavior and can change the regressive lag mode damping by 50% for ground resonance and 80% for air resonance in hover. Author (Hemer)

A95-83661

CONSIDERATIONS IN THE DEVELOPMENT OF THE COUPLED ROTOR FUSELAGE MODEL

ROBERT E. HANSFORD Westland Helicopters Limited, Yeovil, Somerset, UK American Helicopter Society, Journal (ISSN 0002-8711) vol. 39, no. 4 October 1994 p. 70-81 Research sponsored by the United Kingdom Ministry of Defence (HTN-95-61077) Copyright

A collaborative program between Westland Helicopters Limited and the Defense Research Agency has culminated in the first software release of the Coupled Rotor Fuselage Model (CRFM). The constituent modules of this new code are described and associated examples are proved to illustrate the advantages of CRFM to enhance rotorcraft modeling. The rotor dynamics representation is based on a complex rotor mode analysis which is designed to accommodate a wide range of hub configurations and is coupled to the fuselage dynamics to include hub motions. Algorithms for the timewise solution of modal response are reviewed and a new technique is described which provides a more accurate spanwise Force Integration procedure to determine rotor loads. A main feature of CRFM is to extend simulation to maneuvering flight conditions. To achieve this, a pilot control logic is discussed to realistically fly three dimensional maneuvers, and a new wake model is included to address the first order implications of maneuvering flight on the wake geometry. Author (Hemer)

A95-83662

FAST FLOQUET THEORY AND TRIM FOR MULTI-BLADED ROTORCRAFT

DAVID A. PETERS Washington Univ., St. Louis, MO, US American Helicopter Society, Journal (ISSN 0002-8711) vol. 39, no. 4 October 1994 p. 82-89 (Contract(s)/Grant(s): DAAL03-93-G-002; DAAH04-94-6-0351) (HTN-95-61078) Copyright

Dynamic analysis of rotorcraft usually involves a nonlinear trim solution followed by a linearized Floquet analysis. This paper utilizes results by McNulty and by McVicar and Bradley to show that, when the rotor is composed of Q identical blades, both the Floquet analysis and the trim can be obtained in $1/Q$ of the normal computing times. This paper also generalizes the earlier work to show that these savings can be obtained for most Floquet algorithms and for either individual-blade or multi-blade descriptions. Finally, the general result leads to a new formulation of multi-blade coordinates. Author (Hemer)

A95-84195

ACCURACY AND EFFICIENCY ASSESSMENTS FOR A WEAK STATEMENT CFD ALGORITHM FOR HIGH-SPEED AERODYNAMICS

G. S. IANNELLI Univ of Tennessee, Knoxville, TN, United States and A. J. BAKER Journal of Engineering for Gas Turbines and Power, Transactions of the ASME (ISSN 0742-4795) vol. 116, no. 3 July 1994 p. 468-473 refs (BTN-94-EIX95011441238) Copyright

A bilinear finite element, implicit Runge-Kutta space-time discretization has been established for an aerodynamics weak statement CFD algorithm. The algorithm admits real-gas effect simulation, for reliable hypersonic flow characterization, via an equilib-

rium reacting air model. The terminal algebraic system is solved using an efficient block-tridiagonal quasi-Newton linear algebra procedure that employs tensor matrix product factorizations within a lexicographic mesh-sweeping protocol. A block solution-adaptive remeshing, for totally arbitrary convex elements, is also utilized to facilitate accurate shock and/or boundary layer flow resolution. Numerical validations are presented for representative benchmark supersonic-hypersonic aerodynamics problem statements. Author (EI)

A95-85479

COMPRESSIBLE INVISCID VORTEX FLOW OF A SHARP EDGE DELTA WING

J. M. A. LONGO DLR, Braunschweig, Germany AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 680-687 refs (BTN-95-EIX95262694308) Copyright

The influence of the vortex on the flowfield of a delta wing is the focus. The occurrence of shock waves of two types, crossflow and terminating (or rear) shock in the vortical flowfields, are investigated; the possibility of shock-induced vortex breakdown and the effects of compressibility on the rapid performance degradation of delta wings after vortex are studied in detail. It is shown that the onset of the vortex bursting at the wing trailing edge is only weakly influenced by the freestream Mach number. The upstream progression of the vortex bursting, however, is faster for supersonic vortex cores. For transonic flows, terminating shocks are observed downstream of vortex bursting. Crossflow shocks, however, may already develop for low-subsonic freestream Mach numbers. EI

A95-85480

QUIET-FLOW LUDWIG TUBE FOR HIGH-SPEED TRANSITION RESEARCH

STEVEN P. SCHNEIDER Purdue Univ, West Lafayette, IN, United States and CHRISTINE E. HAVEN AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 688-693 refs (BTN-95-EIX95262694309) Copyright

Low-noise supersonic wind tunnels are required for unambiguous experimental research into high-speed laminar-flow instability and transition. The experience of the successful NASA Langley quiet-tunnel development program has been used to design and construct a new kind of low-cost, short-duration, quiet-flow tunnel. Measurements of the flow quality in the 9.7 x 10.9 cm Mach 4 test section were obtained using fast response pressure transducers mounted in the tip of a pitot tube. When the rms pitot pressure is approximately 0.05-0.10% of the mean pitot pressure, bursts of noise appear in the pitot-pressure signals. These bursts appear to be the radiated signature of turbulent spots in the boundary layers on the nozzle walls. Their appearance confirms the presence of laminar nozzle-wall boundary layers and quiet flow when the rms pitot pressure is about 0.06% or less. Based on this criterion, quiet flow is achieved to Reynolds numbers based on the axial length of the quiet-flow test region of more than 400,000 at unit Reynolds numbers of approximately 40,000 per cm. This performance is sufficient for research into receptivity, roughness, and instability effects at high speeds. Author (EI)

A95-86149* National Aeronautics and Space Administration, Ames Research Center, Moffett Field, CA.

EFFECT OF REYNOLDS NUMBER AND TURBULENCE ON AIRFOIL AERODYNAMICS AT -90-DEGREE INCIDENCE

PAUL M. STREMEL NASA, Ames Research Center, Moffett Field, CA, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 449-454

(HTN-95-42320) Copyright

A method has been developed for calculating the viscous flow about airfoils with and without deflected flaps at -90 deg incidence. This method provides for the solution of the unsteady incompressible Navier-Stokes equations by means of an implicit technique. The solution is calculated on a body-fitted computational mesh using a staggered-grid method. The vorticity is defined at the node points, and the velocity components are defined at the mesh-cell sides. The staggered-grid orientation provides for accurate representation of

vorticity at the node points and the continuity equation at the mesh-cell centers. The method provides for the noniterative solution of the flowfield and satisfies the continuity equation to machine zero at each time step. The method is evaluated in terms of its stability to predict two-dimensional flow about an airfoil at -90-deg incidence for varying Reynolds number and laminar/turbulent models. The variations of the average loading and surface pressure distribution due to flap deflection, Reynolds number, and laminar or turbulent flow are presented and compared with experimental results. The comparison indicates that the calculated drag and drag reduction caused by flap deflection and the calculated average surface pressure are in excellent agreement with the measured results at a similar Reynolds number. Author (Hemer)

A95-86150
STOCHASTIC APPROACH TO NOISE MODELING FOR FREE TURBULENT FLOWS

WALID BECHARA Electricite de France, Clamart, France, CHRISTOPHE BAILLY Electricite de France, Clamart, France, PHILIPPE LAFON Electricite de France, Clamart, France, and SEBASTIEN M. CANDEL Ecole Centrale Paris, Chateauf-Malabr, France AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 455-463

(HTN-95-42321) Copyright

A new approach to noise modeling for free turbulent flows is presented. The equations governing the sound field are obtained in two steps. The first step consists of treating the mean and turbulent components of the flow while the acoustic perturbations are neglected. In the second step, a set of equations is derived for the acoustic variables. On the left-hand side of this system, one finds the linearized Euler equations, whereas the right-hand side exhibits source terms related to the turbulent fluctuations and their interactions with the mean flow. These terms are modeled using a stochastic description of the three-dimensional turbulent motion. This is achieved by synthesizing the velocity field at each point in space and for all times with a collection of discrete Fourier modes. The synthesized field possesses the suitable one- and two-point statistical moments and a reasonable temporal power spectral density. The linearized Euler equations including a stochastic description of noise sources are solved numerically with a scheme based on a fractional step treatment. Each one-dimensional problem is solved with a weak formulation. A set of calculations are carried out for a simple freejet. Comparisons between calculations and experiments indicate that a spatial filtering of the source terms is required to obtain the expected level in the far field. Realistic pressure signals, power spectral densities, and sound field patterns are obtained. It is indicated that the stochastic noise generation and radiation (SNGR) approach may be applied to more complex flows because the numerical codes used to calculate the mean flowfield and the wave propagation are not specific of jet configurations. The limitations of the present model lie in the statistical properties of the synthetic turbulent field and in the use of an axisymmetric modeling of the acoustic propagation. Author (Hemer)

A95-86151
MIXING ENHANCEMENT BY AND NOISE CHARACTERISTICS OF STREAMWISE VORTICES IN AN AIR JET

C. B. ROGERS Tufts University, Medford, MA, US and D. E. PAREKH McDonnell Douglas Research Laboratories, St. Louis, MO, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 464-471

(HTN-95-42322) Copyright

Streamwise vortices are generated in the exit of a Mach-0.6 rectangular air jet by half-delta wings at various angles of attack. They entrain close to 50% more mass by 3.7 jet diameters and reduce the downstream jet noise at 23 diameters away from the jet nozzle by up to 3 db. The mixing improvement and jet noise characteristics are both strong functions of the strength and relative position of the vortices. Mass entrainment measurements were measured quantitatively with local pitot-static pressure measurements and through image analysis. The image analysis also gave

average spatial information about the mass entrainment through scalar transport. The results of the acoustic analysis showed that the vortex generators tended to reduce low-frequency noise and introduce high-frequency noise, resulting in noise reduction downstream of the nozzle and an increase in the noise normal to the jet flow. Additionally, as Mach number increased, the downstream jet noise reduction increased. Author (Hemer)

A95-86153* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

REDUCTION OF BLADE-VORTEX INTERACTION NOISE THROUGH POROUS LEADING EDGE

SOOGAB LEE NASA. Ames Research Center, Moffett Field, CA, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 480-488

(HTN-95-42324) Copyright

The effect of the porous leading edge of an airfoil on the blade-vortex interaction noise, which dominates the far-field acoustic spectrum of the helicopter, is investigated. The thin-layer Navier-Stokes equations are solved with a high-order upwind-biased scheme and a multizonal grid system. The Baldwin-Lomax turbulence model is modified for considering transpiration on the surface. The amplitudes of the propagating acoustic wave in the near field are calculated directly from the computation. The porosity effect on the surface is modeled in two ways: (1) imposition of prescribed transpiration velocity distribution and (2) calculation of transpiration velocity distribution by Darcy's law. Results show leading-edge transpiration can suppress pressure fluctuations at the leading edge during blade-vortex interaction and consequently reduce the amplitude of propagating noise by 30% at a maximum in the near field. Author (Hemer)

A95-86156
COMPRESSIBLE NAVIER-STOKES COMPUTATIONS OF MULTIELEMENT AIRFOIL FLOWS USING MULTIBLOCK GRIDS

T. E. NELSON University of Toronto, Downsview, Ontario, Canada, D. W. ZINGG University of Toronto, Downsview, Ontario, Canada, and G. W. JOHNSTON University of Toronto, Downsview, Ontario, Canada AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 506-511

(HTN-95-42327) Copyright

Numerical solutions of the compressible thin-layer Navier-Stokes equations are presented for high-lift multi-element airfoil configurations. Multiblock grids are used, allowing straightforward implementation of an approximately factored implicit algorithm. Interfaces between blocks are treated by overlapping the grids and taking one layer of points from neighboring blocks. Turbulence is modeled using the Baldwin-Barth one-equation turbulence model. High-lift applications presented for comparison with wind tunnel data include: an NACA 4412 airfoil with NACA 4415 flap, a GA(W)-1 airfoil with a 29% chord flap at 30-deg flap angle and two gap settings, and a GA(W)-1 airfoil with 15% chord slat and 29% chord flap. Good agreement with experimental data is obtained for cases with fully attached flow or small regions of separated flow. For cases with extensive regions of flow separation, the thickness and extent of the separated regions are underpredicted. Author (Hemer)

A95-86157* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

NONREFLECTIVE BOUNDARY CONDITIONS FOR HIGH-ORDER METHODS

H. ATKINS NASA. Langley Research Center, Hampton, VA, US and JAY CASPER ViGYAN, Inc., Hampton, VA, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 512-518

(Contract(s)/Grant(s): NAS1-19672)

(HTN-95-42328) Copyright

A different approach to nonreflective boundary conditions for the Euler equations is presented. This work is motivated by a need for inflow and outflow boundary conditions that do not limit the useful accuracy of high-order accurate methods. The primary interest is in the propagation and convection of continuous acoustic and convective waves. This

new approach employs the exact solution to finite waves to relate interior values and ambient conditions to boundary values. The method is first presented in one dimension and then generalized to multidimensions. Grid refinement studies are used to demonstrate high-order convergence for both one-dimensional and two-dimensional flows.

Author (Herner)

A95-86160

SPHERE WAKES AT MODERATE REYNOLDS NUMBERS IN A TURBULENT ENVIRONMENT

J.-S. WU University of Michigan, Ann Arbor, MI, US and G. M. FAETH University of Michigan, Ann Arbor, MI, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 535-541 (Contract(s)/Grant(s): AF-AFOSR-89-0516; F49620-92-J-0399) (HTN-95-42331) Copyright

The structure of sphere wakes in a turbulent environment was measured over the following test range: sphere Reynolds numbers from 135 to 1560, ambient turbulence intensities of roughly 4%, ratios of streamwise spatial integral scales to sphere diameters of 11-59, and ratios of Kolmogorov length scales to sphere diameters of 0.08-0.80. At these conditions, some phenomena observed for sphere wakes at comparable Reynolds numbers in non-turbulent environments were suppressed, like the fast-decaying and self-preserving turbulent wake regions; instead, while the wakes were turbulent, their mean streamwise velocities scaled like self-preserving laminar wakes but with enhanced viscosities due to turbulence. Effective turbulent viscosities were relatively independent of position and ratios of integral length scales and Kolmogorov microscales to sphere diameters; however, they progressively increased with sphere Reynolds numbers. Low and high Reynolds number regimes were observed, separated by a transition regime involving sphere Reynolds numbers in the range from 300 to 600, which was associated with conditions where effects of vortex shedding were prominent in the temporal power spectra measured in the near-wake region.

Author (Herner)

A95-86161

NEAR FIELD OF A COAXIAL JET WITH AND WITHOUT AXIAL EXCITATION

RYAN B. WICKER Stanford University, Stanford, CA, US and JOHN K. EATON Stanford University, Stanford, CA, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 542-546 Research sponsored by the Electric Power Research Institute (HTN-95-42332) Copyright

An experimental study was undertaken to determine the effect of an annular jet on the near-field vortex structure and dynamics of an incompressible axisymmetric jet issuing into a quiescent ambient fluid. The effect of varying the velocity ratio between the two streams was investigated for a single nozzle exit area ratio, a single core flow Reynolds number, and uniform density. A thin laser sheet was used to illuminate the flow for instantaneous photographs of natural and axially excited flow. Natural jet evolution results indicated the initial vortex development in the shear layers occurred independently, but the large-scale structures in the outer layer ultimately controlled the core flow. Axial excitation of the annular flow demonstrated a strong coupling between the large-scale structures in the outer layer and the evolution of the inner layer. Core flow axial excitation produced periodic structures in the inner layer but did not have a significant effect on the evolution of the outer layer.

Author (Herner)

A95-86162

DEVELOPMENT OF A LARGE-ASPECT-RATIO RECTANGULAR TURBULENT FREE JET

W. R. QUINN St. Francis Xavier University, Antigonish, Nova Scotia, Canada AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 547-554 Research sponsored by the Natural Sciences and Engineering Research Council of Canada (HTN-95-42333) Copyright

This paper reports the results of detailed mean flow and turbulence measurements made with hot-wire anemometry in the flowfield of a turbulent free jet of air issuing from a sharp-edged rectangular slot of aspect ratio 20 into still air surroundings. All three

components of the mean velocity vector, the three Reynolds normal stresses and the two Reynolds primary shear stresses were measured. The mean streamwise vorticity and the turbulence kinetic energy have been calculated from the relevant measured data. It was found that the cross section of the jet, in the near flowfield, is dominated by counter-rotating streamwise vortices that facilitate rapid near-field mixing. Rapid mixing is also evidenced by a short potential core length and high values of the turbulence kinetic energy and the Reynolds primary shear stresses compared with those found in an axisymmetric jet at the corresponding streamwise locations. In addition, mean streamwise velocity off-center peaks, which may be the result of the self-induction of the counter-rotating streamwise vortices, were found in the near flowfield, and the jet was found to spread monotonically in the central plane of the slot minor axis and to contract initially in the central plane of the slot major axis.

Author (Herner)

A95-86163

ACTIVE OPEN-LOOP CONTROL OF PARTICLE DISPERSION IN ROUND JETS

ELLEN K. LONGMIRE University of Minnesota, Minneapolis, MN, US and JOHN K. EATON Stanford University, Stanford, CA, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 555-563 Research sponsored by the American Association of University Women, the Link Foundation and the Electric Power Research Institute (HTN-95-42334) Copyright

The objective of this study was to perturb vortex ring structures forming in the near field of a round air jet to modify the dispersion of solid particles in the flow. A jet with Reynolds number based on exit diameter of 1.9×10^4 was loaded with 55-micron diameter glass beads and forced axially with an acoustic speaker. Forcing waveforms were either single or double frequency. Results from flow visualization, laser Doppler anemometry, and quantitative mapping of particle number density show that significant modifications to local particle concentration and dispersion could be achieved.

Author (Herner)

A95-86167* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

INTERFEROMETRIC INVESTIGATIONS OF COMPRESSIBLE DYNAMIC STALL OVER A TRANSIENTLY PITCHING AIRFOIL

M. S. CHANDRASEKHARA Naval Postgraduate School, Monterey, CA, US, L. W. CARR NASA Ames Research Center, Moffett Field, CA, US, and M. C. WILDER MCAT Institute, San Jose, CA, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 586-593 Research sponsored by the Air Force Office of Scientific Research and Army Research Office (HTN-95-42338) Copyright

The compressible dynamic stall flowfield over a NACA 0012 airfoil transiently pitching from 0 to 60 deg at a constant rate under compressible flow conditions has been studied using real-time interferometry. A quantitative description of the overall flowfield, including the finer details of dynamic stall vortex formation, growth, and the concomitant changes in the airfoil pressure distribution, has been provided by analyzing the interferograms. For Mach numbers above 0.4, small multiple shocks appear near the leading edge and are present through the initial stages of dynamic stall. Dynamic stall was found to occur coincidentally with the bursting of the separation bubble over the airfoil. Compressibility was found to confine the dynamic stall vortical structure closer to the airfoil surface. The measurements show that the peak suction pressure coefficient drops with increasing freestream Mach number, and also it lags the steady flow values at any given angle of attack. As the dynamic stall vortex is shed, an anti-clockwise vortex is induced near the trailing edge, which actively interacts with the post-stall flow.

Author (Herner)

A95-86176

HIGH ANGLE-OF-ATTACK AIRFOIL PERFORMANCE IMPROVEMENT BY INTERNAL ACOUSTIC EXCITATION

FEI-BIN HSIAO National Cheng Kung University, Tainan, Taiwan, RONG-NAN SHYU Chung-San Institute of Science and Technol-

ogy, Taichung, Taiwan, and RAY C. CHANG Chung-San Institute of Science and Technology, Taichung, Taiwan AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 655-657 Research sponsored by the National Science Council of the Republic of China (HTN-95-42347) Copyright

The acoustic excitation technique has been widely used in boundary layer and shear flow control for many decades. Invariably, aerodynamic performance about a wing is improved due to an acoustically excited flowfield induced entrainment of momentum exchange in the boundary layer close to the wing surface. The majority of previous studies on airfoil performance improvement always focused on low post-stalled angles, where separated shear flow around the leading-edge airfoil reattaches to the surface after acoustic excitation. An application of a similar methodology to airfoils possessing high angles of attack beyond the stall angle, unfortunately, fails to reveal the effects and the possible mechanism of airfoil performance enhancement. In a detailed study of internal acoustic excitation on aerodynamic performance improvement about a stalled airfoil, Hsiao et al. and Chang et al. found that, at low post-stalled angles of attack, lift was increased with drag being reduced as long as the excitation frequency is locked into the instability frequency of the separated shear layers, and excitation was located near the separation point of the boundary layer. However, at high angles of attack (AOA), the effectiveness of the shear layer instability frequency is still uncertain and deserves further investigation. This Note, therefore, emphasizes the internal acoustic excitation on the stalling airfoil performance improvement with angles of attack beyond 24 deg. Author (Herner)

A95-86177

USING THE LIOU-STEFFEN ALGORITHM FOR THE EULER AND NAVIER-STOKES EQUATIONS

LORENZO BERGAMINI Mississippi State University, Mississippi State, MS, US and PASQUALE CINNELLA Mississippi State University, Mississippi State, MS, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 657-659 Research sponsored by the National Science Foundation and the Polytechnic of Bari (HTN-95-42348) Copyright

Recent years have witnessed the affirmation of both flux-vector and flux-difference techniques for the accurate numerical simulation of compressible fluid flows. Two of the most popular schemes have been proposed by Roe and Van Leer, respectively, and are widely utilized for both inviscid and viscous calculations. However, robustness problems have been experienced by some users of the Roe scheme, and the Van Leer technique has been shown to be too dissipative for viscous calculations. In a related study, the authors investigated the advantages and drawbacks of a new flux-splitting scheme proposed by Liou and Steffen, when compared with the algorithms developed by Van Leer and Roe. The comparison involved inviscid and viscous flows in one and two space dimensions. In this paper, a brief summary of those findings is given.

Author (Herner)

A95-86178

DIFFERENCING OF DENSITY IN COMPRESSIBLE FLOW FOR A PRESSURE-BASED APPROACH

G. P. GREYVENSTEIN Potchefstroom University of CHE, Potchefstroom, South Africa and J. P. MEYER Potchefstroom University of CHE, Potchefstroom, South Africa AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 659-661 (HTN-95-42349) Copyright

Because of the difference in nature between compressible and incompressible flows, different computational schemes have been developed through the years to deal with these two types of flows. In the case of compressible flows, methods have been developed that use density as a primary variable. Such methods are known as density-based methods. Examples of density-based methods are the well-known methods of MacCormack and Beam and Warming. Unlike density-based methods, pressure-based methods use pressure as a primary variable. Examples of pressure-based methods

are the well-known SIMPLE and PISO methods. The purpose of this paper is to investigate the differencing scheme of density used for the convection terms in the momentum transport equations. To provide a clear understanding, we will discuss these concepts in the framework of a one-dimensional scheme. Fortunately, all of these concepts as developed within this one-dimensional framework are readily extended to two or three dimensions. Author (Herner)

A95-86256

A REVIEW OF THE HOT-WIRE TECHNIQUE IN 2-D COMPRESSIBLE FLOW

F. MOTALLEBI Delft Univ. of Technology, The Netherlands Progress in Aerospace Sciences (ISSN 0376-0421) vol. 30, no. 3 1994 p. 267-294

(HTN-95-61157) Copyright

In this paper the use of hot-wire anemometers for obtaining turbulence data in two-dimensional compressible flows has been reviewed. Based on the existing experimental results, the methods of extracting different turbulent quantities from the output signal of the hot-wire anemometer in a given flow environment have been described and evaluated. Comparison between the results obtained with the laser Doppler velocimeter (LDV) and the hot-wire anemometer clearly shows that the latter should be considered as one of the main tools for turbulence research in compressible non-separated turbulent flows not only for its comparable accuracy but also for its much lower cost and ease of operation as compared with the optical methods. Author (Herner)

N95-26382*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

AIRFOIL MODIFICATION EFFECTS ON SUBSONIC AND TRANSONIC PRESSURE DISTRIBUTIONS AND PERFORMANCE FOR THE EA-6B AIRPLANE

DENNIS O. ALLISON and WILLIAM G. SEWALL May 1995 86 p (Contract(s)/Grant(s): RTOP 505-59-10-30) (NASA-TP-3516; L-17360; NAS 1.60:3516) Avail: CASI HC A05/MF A01

Longitudinal characteristics and wing-section pressure distributions are compared for the EA-6B airplane with and without airfoil modifications. The airfoil modifications were designed to increase low-speed maximum lift for maneuvering, while having a minimal effect on transonic performance. Section contour changes were confined to the leading-edge slat and trailing-edge flap regions of the wing. Experimental data are analyzed from tests in the Langley 16-Foot Transonic Tunnel on the baseline and two modified wing-fuselage configurations with the slats and flaps in their retracted positions. Wing modification effects on subsonic and transonic performance are seen in wing-section pressure distributions of the various configurations at similar lift coefficients. The modified-wing configurations produced maximum lift coefficients which exceeded those of the baseline configuration at low-speed Mach numbers (0.300 and 0.400). This benefit was related to the behavior of the wing upper surface leading-edge suction peak and the behavior of the trailing-edge pressure. At transonic Mach numbers (0.725 to 0.900), the wing modifications produced a somewhat stronger nose-down pitching moment, a slightly higher drag at low-lift levels, and a lower drag at higher lift levels. Author

N95-26649*# MCAT Inst., San Jose, CA.

CFD RESEARCH, PARALLEL COMPUTATION AND AERODYNAMIC OPTIMIZATION Final Report, Jul. 1989 - Jan. 1995

JAMES S. RYAN Jan. 1995 7 p Original contains color illustrations (Contract(s)/Grant(s): NCC2-505; NCC2-796) (NASA-CR-197748; NAS 1.26:197748; MCAT-95-18) Avail: CASI HC A02/MF A01; 1 functional color page

Over five years of research in Computational Fluid Dynamics and its applications are covered in this report. Using CFD as an established tool, aerodynamic optimization on parallel architectures is explored. The objective of this work is to provide better tools to

02 AERODYNAMICS

vehicle designers. Submarine design requires accurate force and moment calculations in flow with thick boundary layers and large separated vortices. Low noise production is critical, so flow into the propulsor region must be predicted accurately. The High Speed Civil Transport (HSCT) has been the subject of recent work. This vehicle is to be a passenger vehicle with the capability of cutting overseas flight times by more than half. A successful design must surpass the performance of comparable planes. Fuel economy, other operational costs, environmental impact, and range must all be improved substantially. For all these reasons, improved design tools are required, and these tools must eventually integrate optimization, external aerodynamics, propulsion, structures, heat transfer and other disciplines.

Derived from text

N95-26713 Air Force Systems Command, Wright-Patterson AFB, OH. National Air Intelligence Center.

NUMERICAL INVESTIGATION TO S-INLET FLOWS

(NUMERICAL SIMULATION STUDY OF S-INLET FLOWS)

ZHANG SHUCHENG and HUANG XIJUN 17 Nov. 1994 20 p Transl. into ENGLISH from unidentified Chinese language periodical, p 169-174 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289590; NAIC-ID(RS)T-0922-92) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This work improves Denton's finite volume time marching methods. It takes this type of method, in which there is 1st order accuracy in time and 2d order accuracy in space, and improves it to be a calculation method in which there is 2d degree accuracy in time and 2d degree accuracy in space. In conjunction with this, application is made to numerical simulations of inlet flow fields associated with the interior flows of S type inlets as well as exterior flows which inlets possess. Calculations are carried out for actual cases, and we obtained reasonable calculation results.

DTIC

N95-26719 Air Force Systems Command, Wright-Patterson AFB, OH. National Air Intelligence Center.

PLATE MANIPULATORS

SHI SHENGXI and ZHOU MINGDE 17 Nov. 1994 16 p Transl. into ENGLISH from Kongqidonglixue Xuebao, (China), v. 9, no. 3, Sep. 1991 p 367-371 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289601; NAIC-ID(RS)T-0918-92) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This article reviews the course of the development of research relating to flat plate type turbulence control devices or plate manipulators. It sets up, on the foundation of our own flow visualizations or displays, a proposal for a new drag reduction mechanism. It refines designs, and, in conjunction with that, achieves relatively good drag reduction results.

DTIC

N95-26735* MCAT Inst., San Jose, CA.

NUMERICAL SIMULATION OF THE FLOW ABOUT THE F-18 HARV AT HIGH ANGLE OF ATTACK Final Report

SCOTT M. MURMAN Feb. 1995 36 p Original contains color illustrations

(Contract(s)/Grant(s): NCC2-729)

(NASA-CR-197755; NAS 1.26:197755; MCAT-95-13) Avail: CASI HC A03/MF A01; 2 functional color pages

This research has been aimed at validating numerical methods for computing the flow about the complete F-18 HARV at $\alpha = 30$ deg and $\alpha = 45$ deg. At 30 deg angle of attack, the flow about the F-18 is dominated by the formation, and subsequent breakdown, of strong vortices over the wing leading-edge extensions (LEX). As the angle of attack is increased to $\alpha = 45$ deg, the fuselage forebody of the F-18 contains significant laminar and transitional regions which are not present at $\alpha = 30$ deg. Further, the flow over the LEX at $\alpha = 45$ deg is dominated by an unsteady shedding in time, rather than strong coherent vortices. This complex physics, combined with the complex geometry of a full-aircraft configuration, provides a challenge for current computational fluid dynamics (CFD) techniques. The following sections present the numerical method and grid generation scheme that was

used, a review of prior research done to numerically model the F-18 HARV, and a discussion of the current research. The current research is broken into three main topics; the effect of engine-inlet mass-flow rate on the F-18 vortex breakdown position, the results using a refined F-18 computational model to compute the flow at $\alpha = 30$ deg and $\alpha = 45$ deg, and research done using the simplified geometry of an ogive-cylinder configuration to investigate the physics of unsteady shear-layer shedding. The last section briefly summarizes the discussion.

Derived from text

N95-26740# Tokyo Univ., Sagamihara (Japan). Inst. of Space and Astronautical Science.

WIND TUNNEL EXPERIMENTS ON WAKE FLOW FIELD BEHIND A REENTRY CAPSULE FROM A VIEWPOINT OF PARACHUTE DEPLOYMENT AT SUPERSONIC SPEEDS

KOJIRO SUZUKI and TAKASHI ABE Dec. 1994 27 p Repr. from Institute of Space and Astronautical Science Report No. 655 (Sagamihara, Japan, Tokyo Univ.), Dec. 1994 p 1-24 (ISSN 0285-6808)

(ISAS-655) Avail: CASI HC A03/MF A01

The wake flow field behind the EXPRESS capsule at supersonic speeds is studied experimentally in the wind tunnel. The schlieren photographs and the measurements of the Pitot pressure and the static pressure in the wake clarify the structure of the wake flow field and the effects of the freestream Mach number on it. The wake structure is classified into two types, that is, the subsonic wake neck type and the supersonic wake neck type. The flow characteristics of each wake neck type are discussed. From a viewpoint of the parachute deployment, the effects of the freestream Mach number on the dynamic pressure in the wake are investigated. The recovery ratio of the dynamic pressure in the wake increases with the decrease in the Mach number. At lower Mach number, however, the recovery is delayed due to the extension of the recirculating region behind the capsule bottom. The numerical simulations of the wake flow field are carried out by solving the laminar Navier-Stokes equations and it is pointed out that the recovery of the flow velocity and the dynamic pressure may be enhanced significantly by the turbulent transition on the wake trail.

Author

N95-26757 Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.

EFFECTS OF THREE-DIMENSIONAL IMPOSED 3-D DISTURBANCES ON BLUFF-BODY NEAR WAKE FLOWS Final Report

ALBIN A. SZEWCZYK and PETER W. BEARMAN 1994 6 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): N00014-90-J-4083)

(AD-A289553) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This experimental research effort focuses on the underlying three-dimensional flow structure in the near wake of a bluff body when subjected to imposed geometrical disturbances. To understand the effects of three dimensionality that are characterized by vortex splitting and looping and how they are related to other wake parameters such as base pressure shedding frequency, wake width and wake formation length.

DTIC

N95-26760* MCAT Inst., San Jose, CA.

DEVELOPMENT OF AN UPWIND, FINITE-VOLUME CODE WITH FINITE-RATE CHEMISTRY Final Report, 1 Aug. 1994 - 31 Jan. 1995

GREGORY A. MOLVIK Jan. 1995 19 p Original contains color illustrations

(Contract(s)/Grant(s): NCC2-498)

(NASA-CR-197747; NAS 1.26:197747; MCAT-95-01) Avail: CASI HC A03/MF A01; 5 functional color pages

Under this grant, two numerical algorithms were developed to predict the flow of viscous, hypersonic, chemically reacting gases over three-dimensional bodies. Both algorithms take advantage of the benefits of upwind differencing, total variation diminishing tech-

niques and of a finite-volume framework, but obtain their solution in two separate manners. The first algorithm is a zonal, time-marching scheme, and is generally used to obtain solutions in the subsonic portions of the flow field. The second algorithm is a much less expensive, space-marching scheme and can be used for the computation of the larger, supersonic portion of the flow field. Both codes compute their interface fluxes with a temporal Riemann solver and the resulting schemes are made fully implicit including the chemical source terms and boundary conditions. Strong coupling is used between the fluid dynamic, chemical and turbulence equations. These codes have been validated on numerous hypersonic test cases and have provided excellent comparison with existing data. This report summarizes the research that took place from August 1, 1994 to January 1, 1995. Author

**N95-26854 Aeronautical Systems Div., Eglin AFB, FL.
USER DOCUMENTATION OF THE CTA PROGRAM Final
Report, Sep. - Nov. 1994**

GREG WILDER Nov. 1994 50 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289508; ASC-TR-94-1022) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This report is a user's manual for the CTA program. CTA is a FORTRAN program which converts Cartesian aero-angle aerodynamic coefficients, as generated by the Missile DATCOM aerodynamic prediction code, to polar aeroballistic angle coefficients. The output format of the aeroballistic coefficients matches the format used in the CADAC 6 DOF flyout simulation. DTIC

N95-26859 Air Force Systems Command, Wright-Patterson AFB, OH. National Air Intelligence Center.

**A NUMERICAL METHOD FOR UNSTEADY TRANSONIC
FLOW ABOUT WINGS WITH CONTROL SURFACES**

TAO YU and JIANBAI ZHANG 15 Dec. 1994 17 p Transl. into ENGLISH from Kongqidonglixue Xuebao (China), v. 9, no. 3, Sep. 1991 p 338-343 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289631; NAIC-ID(RS)T-0920-92) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This article introduces a type of finite difference calculation method for unsteady transonic speed flows associated with wings having control surfaces. The equations which are chosen for use are modified three dimensional nonsteady transonic speed small perturbation geopotential equations. Use is made of time integration methods. Solution forms are approximate factor type resolutions of alternating direction implicit (ADI) type forms. Use is made of this type of method to calculate the unsteady aerodynamic forces associated with F-5 wings in oncoming flows with Mach numbers of 0.9 and 0.925 as well as the unsteady aerodynamic forces associated with control surface oscillations. Comparisons were carried out of calculation results with NLR test results from outside of China and calculation results from XTRAN3S methods. This clearly showed that calculations were successful. DTIC

N95-26901 Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**PERFORMANCE CHARACTERIZATION OF A HIGHLY-
OFFSET DIFFUSER WITH AND WITHOUT BLOWING
VORTEX GENERATOR JETS M.S. Thesis**

MICHAEL B. SENSENEY Dec. 1994 191 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289334; AFIT/GAE/ENY/94D-14) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The effect of blowing vortex generator jets (VGJ's) on the performance of a highly-offset (s-duct) diffuser was investigated experimentally. VGJ's are pitched, skewed jets which generate streamwise vortices as well as injecting high-momentum fluid into

the boundary layer. Diffuser performance with and without VGJ's was measured for an inlet Mach number of 0.6 ($Re/x = 1.27e7$ per cm). Pitot static and hot-film instrumentation was used to measure flow properties at the diffuser inlet and exit planes. Without blowing, the flow on the lower surface of the diffuser was massively separated. Blowing at 0.48% mass flow ratio through three lower-surface VGJ's reduced the size of the separated flow region, reduced the thickness of the boundary layer at the exit plane, increased pressure recovery by 1.3%, and increased the static pressure rise achieved in the diffuser by over 50%. Turbulence intensity, turbulent shear stress, and turbulent kinetic energy were reduced as well. Distortion of the exit plane flowfield increased with blowing. DTIC

**N95-26946# Wichita State Univ., Wichita, KS.
CREATING AN ALTERNATIVE PARAMETER OPTIMIZATION
METHOD (APO) Abstract Only**

WILLIAM C. FORREST In its AIAA Techfest 20 Proceedings 8 p 1994

Avail: CASI HC A02/MF A03

Current project goals are (1) to couple a numerical optimization scheme to an existing airfoil design code to enable multiple-objective optimization, targeted optimization, and alternative airfoil definition; and (2) to demonstrate validation/application of the enhanced design method. This viewgraph presentation gives a background on optimization processes in general and earlier applications to airfoils; implementation of the goals in the codes EPPLER, KS-OPT, and APO; and the resulting airfoils generated. CASI

**N95-26953# Wichita State Univ., Wichita, KS. Dept. of Aerospace
Engineering.**

**THE NEAR-WAKE FLOW BEHAVIOR OF AN OSCILLATING
AIRFOIL WITH MODIFIED TRAILING EDGE**

ROY Y. MYOSE and JIRO IWATA In its AIAA Techfest 20 Proceedings 12 p 1994

Avail: CASI HC A03/MF A03

This report covers work which produced the following conclusions: (1) complex three-dimensional vortices were shed as a result of oscillating an airfoil with saw-tooth trailing edge; (2) results from the turbulent boundary layer simulation experiment were consistent with envisioned vortical system; and (3) flow conditions at trailing edge have significant influence on performance of airfoil. No work was done on oscillating airfoils with modified trailing edge. CASI

N95-26955# Wichita State Univ., Wichita, KS.

**AN EXPERIMENTAL INVESTIGATION OF HELICOPTER
DOWNWASH AND TAILBOOM INTERACTION AT THE
WICHITA STATE UNIVERSITY 7X10 FOOT WIND TUNNEL
SCOT KRUSE, JAMES E. LEIGH, KEVIN A. MOORE, and SCOTT
RANDLE In its AIAA Techfest 20 Proceedings 12 p 1994**

Avail: CASI HC A03/MF A03

The two goals of this experiment were: (1) to study the unsteady aerodynamics of a helicopter main rotor in hovering flight; and (2) test the wind tunnel's instrumentation speed for velocity and pressure measurement. Derived from text

**N95-27248# Overset Methods, Inc., Los Altos, CA.
GLOBAL FLOWFIELD ABOUT THE V-22 TILTROTOR
AIRCRAFT Progress Report**

ROBERT L. MEAKIN 23 Mar. 1995 18 p Submitted for publication (Contract(s)/Grant(s): NCC2-747) (NASA-CR-198603; NAS 1.26:198603; OMI-01-92) Avail: CASI HC A03/MF A01

The Chimera overset grid method is reviewed and discussed in the context of a method of solution and analysis of unsteady three-dimensional viscous flows. The state of maturity of the various pieces of support software required to use the approach is discussed. A variety of recent applications of the method is presented. Current limitations of the approach are identified. Author

N95-27258*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CALCULATION OF THREE-DIMENSIONAL (3-D) INTERNAL FLOW BY MEANS OF THE VELOCITY-VORTICITY FORMULATION ON A STAGGERED GRID
 PAUL M. STREMEL May 1995 35 p
 (Contract(s)/Grant(s): RTOP 505-59-36)
 (NASA-TM-110352; A-950063; NAS 1.15:110352) Avail: CASI HC A03/MF A01

A method has been developed to accurately compute the viscous flow in three-dimensional (3-D) enclosures. This method is the 3-D extension of a two-dimensional (2-D) method developed for the calculation of flow over airfoils. The 2-D method has been tested extensively and has been shown to accurately reproduce experimental results. As in the 2-D method, the 3-D method provides for the non-iterative solution of the incompressible Navier-Stokes equations by means of a fully coupled implicit technique. The solution is calculated on a body fitted computational mesh incorporating a staggered grid methodology. In the staggered grid method, the three components of vorticity are defined at the centers of the computational cell sides, while the velocity components are defined as normal vectors at the centers of the computational cell faces. The staggered grid orientation provides for the accurate definition of the vorticity components at the vorticity locations, the divergence of vorticity at the mesh cell nodes and the conservation of mass at the mesh cell centers. The solution is obtained by utilizing a fractional step solution technique in the three coordinate directions. The boundary conditions for the vorticity and velocity are calculated implicitly as part of the solution. The method provides for the non-iterative solution of the flow field and satisfies the conservation of mass and divergence of vorticity to machine zero at each time step. To test the method, the calculation of simple driven cavity flows have been computed. The driven cavity flow is defined as the flow in an enclosure driven by a moving upper plate at the top of the enclosure. To demonstrate the ability of the method to predict the flow in arbitrary cavities, results will be shown for both cubic and curved cavities. Author

N95-27541# National Renewable Energy Lab., Golden, CO.
WIND-TUNNEL TEST OF THE S814 THICK ROOT AIRFOIL
 D. M. SOMERS (Airfoils, Inc., State College, PA.) and J. L. TANTLER Jan. 1995 7 p Presented at the 1995 American Society of Mechanical Engineers (ASME) Energy Sources Technology Conference and Exhibition, Houston, TX, 29 Jan. - 1 Feb. 1995
 (Contract(s)/Grant(s): DE-AC36-83CH-10093)
 (DE95-000268; NREL/TP-442-7388; CONF-950116-7) Avail: CASI HC A02/MF A01

The objective of this wind-tunnel test was to verify the predictions of the Eppler Airfoil Design and Analysis Code for a very thick airfoil having a high maximum lift coefficient $c_{(sub L, max)}$ designed to be largely insensitive to leading edge roughness effects. The 24-percent-thick S814 airfoil was designed with these characteristics to accommodate aerodynamic and structural considerations for the root region of a wind-turbine blade. In addition, the airfoil's maximum lift-to-drag ratio was designed to occur at a high lift coefficient. To accomplish the objective, a two-dimensional wind-tunnel test of the S814 thick root airfoil was conducted in January 1994 in the low-turbulence wind tunnel of the Delft University of Technology Low Speed Laboratory. Data were obtained for transition-free and transition-fixed conditions at Reynolds numbers of 0.7, 1.0, 1.5, 2.0, and 3.0×10^6 . For the design Reynolds numbers of 1.5×10^6 , the transition-free $c_{(sub L, max)}$ is 1.3 which satisfies the design specification. However, this value is significantly lower than the predicted $c_{(sub L, max)}$ of almost 1.6. With transition-fixed at the is 1.2. The difference in $c_{(sub L, max)}$ between the transition-free and transition-fixed conditions demonstrates the airfoil's minimal sensitivity to roughness effects. The S814 root airfoil was designed to complement existing NREL low $c_{(sub L, max)}$ tip-region airfoils for rotor blades 10 to 15 meters in length. DOE

N95-27974*# Rockwell International Corp., Golden, CO. Wind Energy Research Center.
HORIZONTAL AXIS WIND TURBINE POST STALL AIRFOIL CHARACTERISTICS SYNTHESIZATION
 JAMES L. TANTLER and CYRUS OSTOWARI (Texas A&M Univ., College Station, TX.) In DASCON Engineering, Collected Papers on Wind Turbine Technology p 35-39 May 1995
 (Contract(s)/Grant(s): DE-AC04-76DP-03533)
 Avail: CASI HC A01/MF A03

Blade-element/momentum performance prediction codes are routinely used for wind turbine design and analysis. A weakness of these codes is their inability to consistently predict peak power upon which the machine structural design and cost are strongly dependent. The purpose of this study was to compare post-stall airfoil characteristics synthesization theory to a systematically acquired wind tunnel data set in which the effects of aspect ratio, airfoil thickness, and Reynolds number were investigated. The results of this comparison identified discrepancies between current theory and the wind tunnel data which could not be resolved. Other factors not previously investigated may account for these discrepancies and have a significant effect on peak power prediction. Author

N95-27975*# Oregon State Univ., Corvallis, OR.
PRELIMINARY ANALYSIS OF DYNAMIC STALL EFFECTS ON A 91-METER WIND TURBINE ROTOR
 ROBERT E. WILSON In DASCON Engineering, Collected Papers on Wind Turbine Technology p 41-46 May 1995
 Avail: CASI HC A02/MF A03

Analytical investigation of dynamic stall on HAWT (horizontal-axis wind turbines) rotor loads was conducted. Dynamic stall was modeled using the Gormont approach on the MOD-2 rotor, treating the blade as a rigid body teetering about a fixed axis. Blade flapwise bending moments at station 370 were determined with and without dynamic stall for spatial variations in local wind speed due to wind shear and yaw. The predicted mean flapwise bending moments were found to be in good agreement with test results. Results obtained with and without dynamic stall showed no significant difference for the mean flapwise bending moment. The cyclic bending moments calculated with and without dynamic stall effects were substantially the same. None of the calculated cyclic loads reached the level of the cyclic loads measured on the MOD-2 using the Boeing five-minute-average technique. Author

N95-27976*# Wichita State Univ., Wichita, KS.
COMPARATIVE WIND TUNNEL TESTS OF NACA 23024 AIRFOILS WITH SEVERAL AILERON AND SPOILER CONFIGURATIONS

W. H. WENTZ, JR. and M. H. SNYDER In DASCON Engineering, Collected Papers on Wind Turbine Technology p 47-52 May 1995
 Presented at the DOE/NASA Workshop on Horizontal Axis Wind Turbine Technology, Cleveland, OH, 8-10 May 1994
 (Contract(s)/Grant(s): NSG-3277)
 Avail: CASI HC A02/MF A03

This paper reviews research efforts at Wichita State University sponsored by NASA Lewis Research Center to design and evaluate aerodynamic braking devices which will be smaller and lighter than full-chord blade pitch control. Devices evaluated include a variety of aileron configurations, and spoilers located at both trailing edge and near the leading edge. The paper discusses analytical modeling, wind tunnel tests, and for some configurations, full-scale rotor tests. Current designs have not provided adequate control power at high angles of attack (low tip-speed-ratios). The reasons for these limitations are discussed. Analysis and wind tunnel test data indicate that several options are available to the designer to provide aerodynamic slowdown without full-chord pitch control. Three options are suggested; adding venting in front of the control surface hingeline, using spoilers located near the leading edge, and using a two-piece control combining downward deflection inboard with upward deflection outboard. Author

**N95-27977*# Ohio State Univ., Columbus, OH.
COMPARATIVE WIND TUNNEL TEST AT HIGH REYNOLDS
NUMBERS OF NACA 64 621 AIRFOILS WITH TWO AILERON
CONFIGURATIONS**

G. M. GREGOREK *In* DASCON Engineering, Collected Papers on Wind Turbine Technology p 53-66 May 1995 Presented at the DOE/NASA Workshop on Horizontal Axis Wind Turbine Technology, Cleveland, OH, 8-10 May 1984
(Contract(s)/Grant(s): NAG3-330)
Avail: CASI HC A03/MF A03

An experimental program to measure the aerodynamic characteristics of the NACA 64-621 airfoil when equipped with plain ailerons of 0.38 chord and 0.30 chord and with 0.38 chord balanced aileron has been conducted in the pressurized O.S.U. 6 x 12 ft High Reynolds Number Wind Tunnel. Surface pressures were measured and integrated to yield lift and pressure drag coefficients for angles of attack from -3 to +42 deg and for selected aileron deflections from 0 to -90 deg at nominal Mach and Reynolds numbers of 0.25 and 5 x 10 (exp 6). When resolved into thrust coefficient for wind turbine aerodynamic control applications, the data indicated the anticipated decrease in thrust coefficient with negative aileron deflection at low angles of attack; however, as angle of attack increased, thrust coefficients eventually became positive. All aileron configurations, even at -90 deg deflections showed this trend. Hinge moments for each configuration complete the data set. Author

**N95-27978*# Boeing Aerospace Co., Seattle, WA.
COMPARATIVE PERFORMANCE TESTS ON THE MOD-2,
2.5-MW WIND TURBINE WITH AND WITHOUT VORTEX
GENERATORS**

G. E. MILLER *In* DASCON Engineering, Collected Papers on Wind Turbine Technology p 67-77 May 1995 Presented at the DOE/NASA Workshop on Horizontal Axis Wind Turbine Technology, Cleveland, OH, 8-10 May 1984
Avail: CASI HC A03/MF A03

A test program was conducted on the third Mod-2 unit at Goldendale, Washington, to systematically study the effect of vortex generators (VG's) on power performance. The subject unit was first tested without VG's to obtain baseline data. Vortex generators were then installed on the mid-blade assemblies, and the resulting 70% VG configuration was tested. Finally, vortex generators were mounted on the tip assemblies, and data was recorded for the 100% VG configuration. This test program and its results are discussed in this paper. The development of vortex generators is also presented. Author

**N95-27981*# General Electric Co., Philadelphia, PA.
AEROELASTIC STABILITY OF WIND TURBINE BLADE/
AILERON SYSTEMS**

J. C. STRAIN and L. MIRANDY (General Electric Co., Schenectady, NY.) *In* DASCON Engineering, Collected Papers on Wind Turbine Technology p 99-114 May 1995
(Contract(s)/Grant(s): DEN3-153)
Avail: CASI HC A03/MF A03

Aeroelastic stability analyses have been performed for the MOD-5A blade/aileron system. Various configurations having different aileron torsional stiffness, mass unbalance, and control system damping have been investigated. The analysis was conducted using a code recently developed by the General Electric Company - AILSTAB. The code extracts eigenvalues for a three degree of freedom system, consisting of: (1) a blade flapwise mode; (2) a blade torsional mode; and (3) an aileron torsional mode. Mode shapes are supplied as input and the aileron can be specified over an arbitrary length of the blade span. Quasi-steady aerodynamic strip theory is used to compute aerodynamic derivatives of the wing-aileron combination as a function of spanwise position. Equations of motion are summarized herein. The program provides rotating blade stability boundaries for torsional divergence, classical flutter (bending/torsion) and wing/aileron flutter. It has been checked out against fixed-wing results published by Theodorsen and Garrick. The MOD-5A system is stable with respect to divergence and classical flutter for

all practical rotor speeds. Aileron torsional stiffness must exceed a minimum critical value to prevent aileron flutter. The nominal control system stiffness greatly exceeds this minimum during normal operation. The basic system, however, is unstable for the case of a free (or floating) aileron. The instability can be removed either by the addition of torsional damping or mass-balancing the ailerons. The MOD-5A design was performed by the General Electric Company, Advanced Energy Program Department under Contract DEN3-153 with NASA Lewis Research Center and sponsored by the Department of Energy. Author

N95-28003*# Clemson Univ., SC. Dept. of Mechanical Engineering.

**A GENERAL THEORY OF TWO- AND THREE-DIMENSIONAL
ROTATIONAL FLOW IN SUBSONIC AND TRANSONIC
TURBOMACHINES Final Report**

CHUNG-HUA WU May 1993 241 p
(Contract(s)/Grant(s): NAG3-1072; RTOP 505-90-21; RTOP 335-05-01)
(NASA-CR-4496; E-7267; NAS 1.26:4496) Avail: CASI HC A11/MF A03

This report represents a general theory applicable to axial, radial, and mixed flow turbomachines operating at subsonic and supersonic speeds with a finite number of blades of finite thickness. References reflect the evolution of computational methods used, from the inception of the theory in the 50's to the high-speed computer era of the 90's. Two kinds of relative stream surfaces, $S(\text{sub } 1)$ and $S(\text{sub } 2)$, are introduced for the purpose of obtaining a three-dimensional flow solution through the combination of two-dimensional flow solutions. Nonorthogonal curvilinear coordinates are used for the governing equations. Methods of computing transonic flow along $S(\text{sub } 1)$ and $S(\text{sub } 2)$ stream surfaces are given for special cases as well as for fully three-dimensional transonic flows. Procedures pertaining to the direct solutions and inverse solutions are presented. Information on shock wave locations and shapes needed for computations are discussed. Experimental data from a Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt e.V. (DFVLR) rotor and from a Chinese Academy of Sciences (CAS) transonic compressor rotor are compared with the computed flow properties. Author (revised)

N95-28193*# Virginia Polytechnic Inst., Blacksburg, VA. Dept. of Aerospace and Ocean Engineering.

**FLOW STRUCTURE GENERATED BY PERPENDICULAR
BLADE VORTEX INTERACTION AND IMPLICATIONS FOR
HELICOPTER NOISE PREDICTIONS Semiannual Report**

WILLIAM J. DEVENPORT and STEWART A. L. GLEGG (Florida Atlantic Univ., Boca Raton, FL.) Apr. 1995 53 p Original contains color illustrations
(Contract(s)/Grant(s): NAG1-1539)
(NASA-CR-198590; NAS 1.26:198590) Avail: CASI HC A04/MF A01; 15 functional color pages

This report summarizes accomplishments and progress for the period ending April 1995. Much of the work during this period has concentrated on preparation for an analysis of data produced by an extensive wind tunnel test. Time has also been spent further developing an empirical theory to account for the effects of blade-vortex interaction upon the circulation distribution of the vortex and on preliminary measurements aimed at controlling the vortex core size. Derived from text

**N95-28230*# Boeing Military Airplane Development, Seattle, WA.
TRANAIR: A FULL-POTENTIAL, SOLUTION-ADAPTIVE,
RECTANGULAR GRID CODE FOR PREDICTING SUBSONIC,
TRANSONIC, AND SUPERSONIC FLOWS ABOUT
ARBITRARY CONFIGURATIONS. USER'S MANUAL**

F. T. JOHNSON, S. S. SAMANT, M. B. BIETERMAN, R. G. MELVIN, D. P. YOUNG, J. E. BUSSOLETTI, and C. L. HILMES Dec. 1992 198 p
(Contract(s)/Grant(s): NAS2-12513; RTOP 505-61-21)
(NASA-CR-4349; A-90092; NAS 1.26:4349) Avail: CASI HC A09/

MF A03

The TranAir computer program calculates transonic flow about arbitrary configurations at subsonic, transonic, and supersonic freestream Mach numbers. TranAir solves the nonlinear full potential equations subject to a variety of boundary conditions modeling wakes, inlets, exhausts, porous walls, and impermeable surfaces. Regions with different total temperature and pressure can be represented. The user's manual describes how to run the TranAir program and its graphical support programs. Author

N95-28241*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MEASUREMENTS OF STORE FORCES AND MOMENTS AND CAVITY PRESSURES FOR A GENERIC STORE IN AND NEAR A BOX CAVITY AT SUBSONIC AND TRANSONIC SPEEDS

ROBERT L. STALLINGS, JR. (Lockheed Engineering and Sciences Co., Hampton, VA.), E. B. PLETOVICH, M. B. TRACY, and MICHAEL J. HEMSCH (Lockheed Engineering and Sciences Co., Hampton, VA.) May 1995 178 p
 (Contract(s)/Grant(s): RTOP 505-68-70-09)
 (NASA-TM-4611; L-17388; NAS 1.15:4611) Avail: CASI HC A09/MF A02

An experimental force and moment study was conducted in the Langley 8-Foot Transonic Pressure Tunnel for a generic store in and near rectangular box cavities contained in a flat-plate configuration at subsonic and transonic speeds. Surface pressures were measured inside the cavities and on the flat plate. The length-to-height ratios were 5.42, 6.25, 10.83, and 12.50. The corresponding width-to-height ratios were 2.00, 2.00, 4.00, and 4.00. The free-stream Mach number range was from 0.20 to 0.95. Surface pressure measurements inside the cavities indicated that the flow fields for the shallow cavities were either closed or transitional near the transitional/closed boundary. For the deep cavities, the flow fields were either open or near the open/transitional boundary. The presence of the store did not change the type of flow field and had only small effects on the pressure distributions. For transitional or open transitional flow fields, increasing the free-stream Mach number resulted in large reductions in pitching-moment coefficient. Values of pitching-moment coefficient were always much greater for closed flow fields than for open flow fields. Author

N95-28265*# Boeing Military Airplane Development, Seattle, WA.
TRANAIR: A FULL-POTENTIAL, SOLUTION-ADAPTIVE, RECTANGULAR GRID CODE FOR PREDICTING SUBSONIC, TRANSONIC, AND SUPERSONIC FLOWS ABOUT ARBITRARY CONFIGURATIONS. THEORY DOCUMENT

F. T. JOHNSON, S. S. SAMANT, M. B. BIETERMAN, R. G. MELVIN, D. P. YOUNG, J. E. BUSSOLETTI, and C. L. HILMES Dec. 1992 252 p
 (Contract(s)/Grant(s): NAS2-12513; RTOP 505-61-21)
 (NASA-CR-4348; A-90093; NAS 1.26:4348) Avail: CASI HC A12/MF A03

A new computer program, called TranAir, for analyzing complex configurations in transonic flow (with subsonic or supersonic freestream) was developed. This program provides accurate and efficient simulations of nonlinear aerodynamic flows about arbitrary geometries with the ease and flexibility of a typical panel method program. The numerical method implemented in TranAir is described. The method solves the full potential equation subject to a set of general boundary conditions and can handle regions with differing total pressure and temperature. The boundary value problem is discretized using the finite element method on a locally refined rectangular grid. The grid is automatically constructed by the code and is superimposed on the boundary described by networks of panels; thus no surface fitted grid generation is required. The nonlinear discrete system arising from the finite element method is solved using a preconditioned Krylov subspace method embedded in an inexact Newton method. The solution is obtained on a sequence of successively refined grids which are either constructed adaptively based on estimated solution errors or are predetermined

based on user inputs. Many results obtained by using TranAir to analyze aerodynamic configurations are presented. Author

N95-28331 Naval Postgraduate School, Monterey, CA.
CONSTRUCTION AND WIND TUNNEL TEST OF A 1/12TH SCALE HELICOPTER MODEL Master's Thesis

MICHAEL A. CAPASSO Sep. 1994 82 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
 (AD-A288487) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This thesis reports on the construction of a 1/12th scale model of the award winning Arapaho attack helicopter design and wind tunnel test to determine both the model and full scale equivalent flat plate area. Tests were conducted for lg level flight and included yawed flight conditions up to 10 degrees. The significance of equivalent flat plate area for helicopters is that it is the principal parameter that establishes rotor propulsive force requirements. The Model was constructed from the original design submitted by the 1993 NPS Helicopter Design Team and is 47.5 inches long with a 48-inch main rotor diameter. The model was tested in the NPS Low Speed Wind Tunnel to measure the drag force on the main body of the model at wind tunnel velocities up to 72 knots. Drag force on the model was also measured with the rotor head and longbow radome installed, and at various yaw angles up to 10 degrees. The equivalent flat plate area was then calculated from these measurements and compared to other helicopters. Recommendations for further wind tunnel testing were made. DTIC

N95-28669*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STUDY OF POTENTIAL AERODYNAMIC BENEFITS FROM SPANWISE BLOWING AT WINGTIP Ph.D. Thesis - George Washington Univ., 1992

RAYMOND E. MINECK Jun. 1995 102 p
 (Contract(s)/Grant(s): RTOP 505-59-10-30)
 (NASA-TP-3515; L-17368; NAS 1.60:3515) Avail: CASI HC A06/MF A02

Comprehensive experimental and analytical studies have been conducted to assess the potential aerodynamic benefits from spanwise blowing at the tip of a moderate-aspect-ratio swept wing. Previous studies on low-aspect-ratio wings indicated that blowing from the wingtip can diffuse the tip vortex and displace it outward. The diffused and displaced vortex will induce a smaller downwash at the wing, and consequently the wing will have increased lift and decreased induced drag at a given angle of attack. Results from the present investigation indicated that blowing from jets with a short chord had little effect on lift or drag, but blowing from jets with a longer chord increased lift near the tip and reduced drag at low Mach numbers. A Navier-Stokes solver with modified boundary conditions at the tip was used to extrapolate the results to a Mach number of 0.72. Calculations indicated that lift and drag increase with increasing jet momentum coefficient. Because the momentum of the jet is typically greater than the reduction in the wing drag and the increase in the wing lift due to spanwise blowing is small, spanwise blowing at the wingtip does not appear to be a practical means of improving the aerodynamic efficiency of moderate-aspectratio swept wings at high subsonic Mach numbers. Author

N95-28674*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NUMERICAL STUDY TO ASSESS SULFUR HEXAFLUORIDE AS A MEDIUM FOR TESTING MULTIELEMENT AIRFOILS

DARYL L. BONHAUS, W. KYLE ANDERSON, and DIMITRI J. MAVRIPLIS (Institute for Computer Applications in Science and Engineering, Hampton, VA.) Jun. 1995 31 p
 (Contract(s)/Grant(s): RTOP 505-59-53-01)
 (NASA-TP-3496; L-17401; NAS 1.60:3496) Avail: CASI HC A03/MF A01

A methodology is described for computing viscous flows of air and sulfur hexafluoride (SF6). The basis is an existing flow solver

that calculates turbulent flows in two dimensions on unstructured triangular meshes. The solver has been modified to incorporate the thermodynamic model for SF6 and used to calculate the viscous flow over two multielement airfoils that have been tested in a wind tunnel with air as the test medium. Flows of both air and SF6 at a free-stream Mach number of 0.2 and a Reynolds number of 9×10^6 are computed for a range of angles of attack corresponding to the wind-tunnel test. The computations are used to investigate the suitability of SF6 as a test medium in wind tunnels and are a follow-on to previous computations for single-element airfoils. Surface-pressure, lift, and drag coefficients are compared with experimental data. The effects of heavy gas on the details of the flow are investigated based on computed boundary-layer and skin-friction data. In general, the predictions in SF6 vary little from those in air. Within the limitations of the computational method, the results presented are sufficiently encouraging to warrant further experiments. Author

03

AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

A95-84557

NEURO-CONTROLLERS FOR ADAPTIVE HELICOPTER TRAINING

K. KRISHNAKUMAR Alabama Univ., AL, US, S. SAWHNEY Alabama Univ., AL, US, and R. WAI Alabama Univ., AL, US In Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993. A95-84553 Warrendale, PA Society of Automotive Engineers, Inc. 1993 p. 37-47 (SAE PAPER 932535) Copyright

This paper presents an application of artificial neural networks in adaptive helicopter hover training of novice student pilots. The design of the adaptive trainer utilizes the hypothesis that novices can be trained to fly a helicopter system automatically (with no human interaction) if the helicopter system adapts to the learning curve of the student. Two different techniques based on the above approach are presented. In the first technique, the helicopter system actively enforces optimality by augmenting the novice's control inputs by amounts necessary to satisfy desired performance criteria. The second technique uses relaxed performance criteria that are not initially optimal, but approach optimality in a graded fashion, based on the learning curve of the student. Adaptive neuro-controllers, together with a critic model, are used to implement the adaptive helicopter system. The results using simulated student models verify the approach adopted, and show that the adaptive neuro-controllers allow the helicopter system to adapt to the novice's learning curve. Author (Herner)

A95-84559

AUTOMATED HOVER TRAINING: AN EMPIRICAL EVALUATION

JACK A. DOHME Army Research Inst. Research and Development Activity, Fort Rucker, AL, US In Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993. A95-84553 Warrendale, PA Society of Automotive Engineers, Inc. (ISSN) 1993 p. 63-67 (SAE PAPER 932536) Copyright

Hovering flight is a critical skill that must be acquired by neophyte helicopter pilots prior to learning other flight maneuvers. Hover training in the aircraft is potentially dangerous given the tendency for neophytes to overcontrol the helicopter near the ground. It is also expensive. The Army uses the UH-1 helicopter for Primary Phase hover training at a cost of approximately \$700.00 per hour with a hover training requirement of approximately 10 - 14 hours per

student. The Automated Hover Trainer (AHT) was designed to provide ab initio pilots with safe, low-cost training in the basic hovering maneuvers: stationary hover, hover taxi, hovering turns, and takeoff to and land from a hover. Research was performed to assess the effectiveness of the AHT by measuring the Transfer of Training (TOT) from the AHT simulator to the helicopter using Army flight students as research subjects. Significant positive TOT was demonstrated for all five hovering maneuvers. Author (Herner)

A95-84560

THE LARGE RADIUS TRACK CENTRIFUGE CONCEPT AS AN ACCELERATION RESEARCH AND SIMULATION DEVICE

DAVID J. PANCRATZ Biodynamic Research Corp., US, JOHN B. BOMAR, JR. Biodynamic Research Corp., US, JAMES H. RADDIN, JR. Biodynamic Research Corp., US, and MICHAEL HESSHEIMER BDM International, Inc., US In Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993. A95-84553 Warrendale, PA Society of Automotive Engineers, Inc. (ISSN) 1993 p. 69-74 (Contract(s)/Grant(s): F41624-93-C-2002) Copyright

Anticipated high agility aircraft will require pilot training and acceleration research to investigate the human capacity to function in the projected environment. Existing man-rated centrifuges and fixed-base simulators are capable of imposing only a portion of the entire envelope of accelerations, and often produce significant artifactual accelerations and illusions. Simulations and engineering analysis of a large radius track centrifuge indicate such a device could impose an acceleration environment suitable for training and research. The technology required for the concept to be feasible in the near future. Author (Herner)

A95-84568

THE CBT ALTERNATIVE FOR AVIATION TRAINING: IS IT MEETING THE NEED?

PERRY S. MAIN TRO Learning, Inc., US In Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993. A95-84553 Warrendale, PA Society of Automotive Engineers, Inc. (ISSN) 1993 p. 129-137 (SAE PAPER 932596) Copyright

Jobs in the aviation industry are characterized by requirements to understand and operate complex, high technology equipment. This paper describes characteristics of current computer-based training (CBT) hardware and software technology. The paper then presents examples of how CBT is used to meet pilot and mechanic training requirements. The future direction of CBT is reviewed with a look at how CBT will respond to advances in desk-top computer technology. Finally the general indirect benefits of CBT are examined as further evidence of the ability of CBT to meet the needs of the aviation industry. Author (Herner)

A95-84570

ASSESSMENT OF COST AND TRAINING EFFECTIVENESS FOR A CANDIDATE TRAINING SYSTEM USING THE COMPARISON-BASED PREDICTION MODEL

B. A. BABBITT Northrop Corp., US, C. A. SEMPLE Northrop Corp., US, and R. J. SPARKS Northrop Corp., US In Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993. A95-84553 Warrendale, PA Society of Automotive Engineers, Inc. (ISSN) 1993 p. 143-148 (SAE PAPER 932598) Copyright

The overall program objective was to identify, develop, and assess training requirements and system development methodologies that could be used to improve the instructional systems development (ISD) process to produce highly cost-effective training systems. A specific cost and training effectiveness analysis (CTEA) model was applied to the design of a training in order to (1) assess the utility of the selected model, and (2) evaluate the concept training system's potential effectiveness and cost. The information gained from this evaluation proved to be useful in making adjustments to the

proposed design of a total training system during its design phase.
Author (Herner)

A95-84571

INTEGRATED FLIGHT CREW TRANSITION TRAINING FOR THE ADVANCED FLIGHT DECK AIRCRAFT

THOMAS L. LEONARD Douglas Aircraft Co., US In Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993. A95-84553 Warrendale, PA Society of Automotive Engineers, Inc. (ISSN) 1993 p. 149-155 (SAE PAPER 932599) Copyright

The purpose of this paper is to examine the decisions, actions, and results occurring in the development and execution of a flight crew transition training program for an advanced flight deck aircraft, specifically the MD-11. Training considerations and strategies highlighted may be applied across the spectrum of advanced aircraft. The new approach to transition training emphasizes development of cognitive skills rather than motor skills. This new approach is applicable to aircraft involving state-of-the-art cockpit displays, computer-controlled systems, and flight crew interaction with a flight management computer. These new technologies demand that students become immersed in the dynamic, real-time environment of aircraft flight at the start of transition training. Properly sequenced CBT lessons reinforced with timely Flight Training Device (FTD) training periods apply the sound and highly effective instructional design axioms of one-on-one instruction, learn by doing, learn by repeating, and experience being the best teacher.

Author (revised by Herner)

A95-84572

NEW TOOLS FOR CREATING INSTRUCTION AND SIMULATIONS

ANDREW S. GIBBONS Utah State Univ., UT, US In Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993. A95-84553 Warrendale, PA Society of Automotive Engineers, Inc. (ISSN) 1993 p. 157-162 (SAE PAPER 932600) Copyright

This paper describes three new tools for the design and development of computer-based training (CBT) in aviation. These tools, rather than making an incremental contribution to training quality, promise to alter our conceptions of the product and to change the nature of the products we are willing to build and use. These tools — simulation shell authoring, object-oriented authoring, and knowledge-based authoring — will modify all three factors of the time-cost-quality equation and bring down barriers that have prevented the development of larger numbers of more highly interactive and flexible instructional forms.

Author (Herner)

A95-84963

PILOT RATING SCALE FOR AIRCRAFT HANDLING QUALITIES

ERIC E. FIORE Fairchild Aircraft, San Antonio, TX, US Cockpit (ISSN 0742-1508) January, February, March 1994 p. 4-15 (HTN-95-42269) Copyright

The purpose of this report is to establish a simple and useful pilot rating scale to serve as a language for communication between the test pilot and the engineering staff. The use of the scale outlined can help project managers make decisions on factors that affect aircraft handling and serve as a basis of comparison for aircraft modifications. Additionally, a section is dedicated to incorporating the pilot rating into a parametric trade-off analysis so that the effects of engineering design changes on the handling quality in question can be quantified.

Author (Herner)

N95-26485 Federal Aviation Administration, Atlanta, GA. Technical Center.

THE 1994 UPDATED NATIONAL AIRSPACE SYSTEM PERFORMANCE ASSESSMENT FOR YEAR 2005

DOUGLAS BAART and ANNY CHEUNG Oct. 1994 31 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(AD-A288652; DOT/FAA/CT-TN94/41; FAA-AOR-100-94-009) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This report documents the evaluation of the National Airspace System (NAS) performance for year 2005. The National Airspace System Performance Analysis Capability (NASPAC) Simulation Modeling System (SMS) was used to simulate the future air traffic control (ATC) system. Airport airfield and technological improvements expected to be completed by year 2005 were included in this analysis. Future air traffic demand was based on the 1993 Terminal Area Forecasts (TAF). The study results indicate that most of the delay in the system for year 2005 is caused by airfield capacity limitations. Three-fourths of the delay is related to ground operations or ground manifestation of airspace congestion. About 45 percent of the total delay is related to ground operations or ground manifestation of airspace congestion. About 45 percent of the total delay is attributed to adverse weather. Airports that have no future airfield improvements planned show the highest delay estimates. DTIC

N95-26497 Lightning Technologies, Inc., Pittsfield, MA. AIRCRAFT FUEL SYSTEM LIGHTNING PROTECTION DESIGN AND QUALIFICATION TEST PROCEDURES DEVELOPMENT Final Report

KEITH E. CROUCH Sep. 1994 193 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): DTFA03-92-C-00003)

(AD-A288401; LT-94-1067; DOT/FAA/CT-94/74) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The Navy and the Air Force recognized the need for improved test procedures for evaluating the lightning protection design of aircraft fuel systems. Under their sponsorship, a program to develop adjustable, standard ignition sources which could be used to calibrate techniques for detecting ignition sources during lightning testing was established. The minimum ignition levels of voltage sparks and hot spots were established under the program before it was terminated due to funding problems. The present program under FAA sponsorship, is a continuation of the original program. The Standard Voltage Spark Ignition Source and the Standard Hot Spot Ignition Source were completed and documented. The most promising approach for developing a Standard Thermal Spark Ignition Source was determined and is presented. Photographic detection techniques were investigated and the limitations determined. The presence of light on a photographic film indicated the possibility of an ignition source but can not confirm the ignition probability (if any). Hydrogen mixtures appear to provide the ability to have adjustable ignition probabilities and low energy (low over-pressure) ignitions. DTIC

N95-26498# National Transportation Safety Board, Washington, DC.

AIRCRAFT ACCIDENT REPORT: CONTROLLED COLLISION WITH TERRAIN TRANSPORTES AEREOS EJECUTIVOS, S.A. (TAESA) LEARJET 25D, XA-BBA DULLES INTERNATIONAL AIRPORT CHANTILLY, VIRGINIA, JUNE 18, 1994

7 Mar. 1995 69 p

(NTSB/AAR-95/02; PB95-910402) Avail: CASI HC A04/MF A01

This report explains the accident involving the TAESA Learjet 25D that crashed near the threshold of runway 1R at Dulles International Airport, Chantilly, Virginia, on June 18, 1994. Safety issues in the report focused on weather at the airport, flightcrew training, qualifications, and performance, flightcrew fatigue, operations specifications, passenger seating, and the ground proximity warning system. Safety recommendations concerning some of these issues were made to the Federal Aviation Administration. Author

N95-26527 Diffrauto Ltd., Windsor (Ontario).

CHARACTERIZATION OF CORROSION AND DEVELOPMENT OF A BREADBOARD OF A D SIGHT AIRCRAFT INSPECTION SYSTEM, PHASE 1 Final Report

F. KARPALA and O. L. HAGENIERS Aug. 1994 369 p Sponsored

by FAA Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A288347; DOT/FAA/CT-94/56) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This report presents Phase 1 results of a joint Project Arrangement between the FAA and Transport Canada Aviation for the development and testing of a nondestructive inspection (NDI) system for aircraft corrosion detection in fuselage lap joints. The process is based on D Sight, an optical technique developed by Diffracto Limited. This research project had the following major components: (1) identification of corrosion areas of concern; (2) collection of corrosion samples; (3) acceleration of specimen corrosion in the laboratory; (4) construction and testing of a breadboard inspection device; and (5) laboratory and field trials of the breadboard device. The outcome can be summarized as follows: (1) a library of aircraft corrosion samples has been established; (2) a corrosion process has been developed that matches in-service corrosion well, (3) a breadboard D Sight NDI system has been built and tested; and (4) a proposal for follow-on work has been completed. DTIC

N95-27186 DACC SCI, Inc., Columbia, MD.
THE USE OF ELECTROCHEMISTRY AND ELLIPSOMETRY FOR IDENTIFYING AND EVALUATING CORROSION ON AIRCRAFT Monthly Report, 15 Sep. - 14 Oct. 1994
CHESTER M. DACRES 14 Oct. 1994 2 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (Contract(s)/Grant(s): F49620-94-C-0042) (AD-A288536; AFOSR-94-0687TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The reporting for this period and the data from the feasibility study show that the signature from the corroding aircraft is repeatable. The first template design for the paint application was abandoned due to the conductive paint consistency. A more practical approach, using adhesive tape to lay the grid pattern, proved a better technique for paint application. Silver paint was added to the test, because it is lower than gold paint in cost and has better electrical conductivity than carbon paint. The conductivity of gold paint increases with cure temperature, which could adversely alter the coating integrity. A cure temperature of 50 C was established for all paints to maintain coating integrity. Last, using the AC Impedance technique, it was found that the two-electrode approach is ideally suited for in-situ real-time analysis of metal/coating systems. CASI

N95-27762* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FURTHER INVESTIGATIONS OF ICING EFFECTS ON AN ADVANCED HIGH-LIFT MULTI-ELEMENT AIRFOIL
DEAN MILLER, JAIWON SHIN, DAVID SHELDON, ABDOLLAH KHODADOUST (McDonnell-Douglas Aerospace, Long Beach, CA.), PETER WILCOX (McDonnell-Douglas Aerospace, Long Beach, CA.), and TAMMY LANGHALS (NYMA, Inc., Brook Park, OH.) May 1995 19 p Presented at the Applied Aerodynamics Conference, San Diego, CA, 19-22 Jun. 1995; sponsored by AIAA (Contract(s)/Grant(s): NAS3-27186; RTOP 505-68-10) (NASA-TM-106947; E-9683; NAS 1.15:106947; AIAA PAPER 95-1880) Avail: CASI HC A03/MF A01

In 1993 an experimental effort was initiated to investigate the effect of ice accretions on an advanced high-lift, multi-element airfoil. This airfoil is representative of an advanced transport wing, and has a state-of-the-art three element high lift system. This experimental effort is part of a cooperative program between McDonnell Douglas Aerospace and the NASA Lewis Research Center. The goal of this program is to improve the current understanding of ice accretion characteristics on multi-element airfoils. One key objective of this program is to establish an experimental database of multi-element ice accretions using the NASA-Lewis icing Research Tunnel (IRT). The first multi-element icing test in this cooperative effort was conducted in 1993. A second 'follow on' icing

test was conducted in 1994, for the purpose of augmenting the multi-element ice accretion database obtained in 1993, and also for studying the effect of flap gap setting on ice accretions. This paper presents selected results from the 1994 multi-element icing test, and will emphasize the effect of angle-of-attack, and flap gap setting on multi-element ice accretions. Author

N95-27859* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
A REVIEW OF FALCONRY AS A BIRD CONTROL TECHNIQUE WITH RECOMMENDATIONS FOR USE AT THE SHUTTLE LANDING FACILITY, JOHN F. KENNEDY SPACE CENTER, FLORIDA, USA
VICKIE L. LARSON (Bionetics Corp., Cocoa Beach, FL.), SEAN P. ROWE (Bionetics Corp., Cocoa Beach, FL.), DAVID R. BREININGER (Bionetics Corp., Cocoa Beach, FL.), and REUVEN YOSEF (Archbold Biological Station, Lake Placid, FL.) Jun. 1994 47 p (Contract(s)/Grant(s): NAS10-11624) (NASA-TM-110142; NAS 1.15:110142) Avail: CASI HC A03/MF A01

Falconry has been proposed as a method of reducing the bird/ aircraft strike hazard, in addition to current bird control techniques, at the Shuttle Landing Facility (SLF), John F. Kennedy Space Center (KSC), Florida, U.S. Bird control programs using falconry have been employed at a number of military and commercial airfields in the U.S., Canada, and Europe. Most falconry programs have been discontinued. In most situations, falconry did not prove cost effective when compared to alternative bird control techniques. Available literature and documents, as well as several raptor specialists and military personnel, suggest that falconry may be useful only against certain problem species and when other bird control methods have been proven inadequate. Because many of the most commonly used falcons are protected species, acquisition of falcons will complicate their use in bird control programs. Many avian species found at the SLF are federally and state protected or of conservation concern, therefore, environmental impacts may also result from the use of falcons. Author

N95-27907* National Academy of Sciences - National Research Council, Washington, DC.
HIGH-STAKES AVIATION: US-JAPAN TECHNOLOGY LINKAGES IN TRANSPORT AIRCRAFT
National Academy Press 1994 152 p (LC-94-65759; ISBN-0-309-05045-6) Copyright Avail: CASI HC A08/MF A02

The context, current status, and implications of U.S.-Japan relationship in the area of development and transfer of aircraft technology are examined. Future trends are evaluated. Policy recommendations to U.S. aircraft manufacturers, the Department of Defense, and NASA concerning the maintaining of U.S. leadership in aircraft manufacturing and aviation are formulated. CASI

N95-28454 Army Natick Research and Development Command, MA.
THE PERFORMANCE OF CARGO AIRDROP SYSTEMS USING G-12E PARACHUTES: STATISTICAL DETERMINATION OF MINIMUM ALTITUDE Final Report, Mar. 1993 - Nov. 1994

STEVEN E. KUNZ Feb. 1995 42 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A291666; NATICK/TR-95/017) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

In order to reduce the exposure of aircraft to hostile fire, the U.S. Air Force is interested in dropping cargo from the lowest possible altitude above ground level. Using trajectory data from previous airdrop system testing, this report statistically determines the minimum altitude above ground level (AOL) from which airdrop systems (comprising clusters of two to three G-12E parachutes) may safely deliver cargoes up to 5000 pounds. The methods used to compute variables of interest, such as system tension and system orientation, are presented. To support this statistical analysis,

03 AIR TRANSPORTATION AND SAFETY

intervals were defined based upon clearly discernible events. This led to a reexamination of so-called functional phases, used by the airdrop community. Some phases were found unsuitable for statistical purposes. To resolve this problem, process intervals were defined based upon clearly discernible process states or events. Based upon the limited data available, it was found that G-12E airdrop systems can safely deliver cargoes of up to 5000 pounds when released from aircraft at an altitude of approximately 300 feet AGL. DTIC

N95-28630 Simula, Inc., Phoenix, AZ.

ROTORCRAFT CRASHWORTHY AIRFRAME AND FUEL SYSTEM TECHNOLOGY DEVELOPMENT PROGRAM Final Report

JOSEPH W. COLTMAN Oct. 1994 175 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): DTFA03-84-R-40032)

(AD-A289986; TR-90425; DOT/FAA/CT-91/7) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

A research program was initiated by the Federal Aviation Administration (FAA) Technical Center to investigate crash resistance design technology applicable to U.S. civil rotorcraft. The purpose of the program was to identify crash resistance design technology consistent with rotorcraft type, primary use, and the expected crash environments for civil helicopters. The program examined crash resistance technology for landing gear, fuselage structure, seating systems, and fuel systems. A trade-off study was conducted to identify an optimum level of crash resistance for three weight classes of civil rotorcraft. The results of the research program were a series of crash impact design and test criteria for civil rotorcraft, as well as an assessment of the weight penalties that would be incurred in meeting these criteria. The program was conducted by Simula Inc. with assistance from Bell Helicopter Textron Inc. and Sikorsky Aircraft. DTIC

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

A95-82462

FLIGHT EVALUATION OF DGPS AND DGPS-INS NAVIGATION SYSTEMS

HIROKIMI SHINGU National Aerospace Laboratory, Tokyo, Japan, KOICHI MATSUSHIMA National Aerospace Laboratory, Tokyo, Japan, TOSHIKI TSUJII National Aerospace Laboratory, Tokyo, Japan, TAKATSUGU ONO National Aerospace Laboratory, Tokyo, Japan, KAZUTOSHI ISHIKAWA National Aerospace Laboratory, Tokyo, Japan, TOSHIHARU INAGAKI National Aerospace Laboratory, Tokyo, Japan, HISASHI YOKOYAMA Electronic Navigation Research Institute, Tokyo, Japan, HIROSHI TOMITA National Space Development Agency, Ibaraki, Japan, and TOMOYUKI MIYANO Toshiba Corporation, Kanagawa, Japan In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 1115-1123 Copyright

This paper presents the results of the flight evaluation of the Differential Global Positioning System (DGPS) - Inertial Navigation System (INS) hybrid navigation system. First, a concept for the configuration of the hybrid navigation system is shown. The functions of DGPS navigation, INS navigation and DGPS-INS hybrid navigation are described. Second, the method used to estimate the navigation outputs using a Kalman filter is shown. Third, an outline of the experiments conducted when the airplane was at rest on the ground is shown, and comparison between navigation performances with the INS only and those with the GPS-INS hybrid system are

presented. Fourth, the experimental results of the DGPS-INS hybrid system onboard the research airplane Do-228 in the orbit and approach phases are shown. The improvement in navigation performance by the DGPS-INS hybrid system is experimentally verified. Finally, it is concluded from the results of flight experiments that the concept for the configuration of DGPS and DGPS-INS navigation systems is promising for aerospace applications. Author (Hemer)

N95-26454 Mitre Corp., McLean, VA. Center for Advanced Aviation System Development.

AIR TRAFFIC OPERATIONAL INVENTORY CY 1994 Final Report

S. L. ROTHER Aug. 1994 248 p Supersedes MTR-90W00179 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): DTFA01-93-C-00001)

(AD-A288281; MTR-94W0000110; DOT/FAA/AT-94/1; MTR-90W00179) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The Federal Aviation Administration's (FAA) air traffic control (ATC) services are provided by Air Route Control Centers (ARTCC's), Combined Center Radar Approach Controls (CERAP's), Terminal Radar Approach Control (TRACON) facilities, and Air Traffic Control Towers (ATCT's). TRACON's are subdivided into Metroplex Control Facilities (MCF's) and standalone facilities. The modernization of these facilities will be based upon operational and economic considerations. This report serves as an inventory reference document for high level operational facility planning and requirements' development. The report presents a current and projected pictorial description of ATC facilities arranged by ARTCC geographic boundaries. All FAA and Department of Defense (DOD) radar facilities and their associated control towers are included. Included is information on radar connectivities, automation equipment, tower display systems, radar operational positions, and air traffic staffing. DTIC

N95-26585# National Aerospace Lab., Tokyo (Japan). Flight Research Div.

FLIGHT EVALUATION OF GPS/DGPS SENSOR SYSTEMS INSTALLED IN NAL DO228

KAZUTOSHI ISHIKAWA, TAKATSUGU ONO, MASAOKI MURATA, TOSHIKI TSUJII, HITOSHI MINENO (National Space Development Agency, Tokyo, Japan.), and SHUICHI MATSUMOTO (National Space Development Agency, Tokyo, Japan.) Mar. 1994 87 p In JAPANESE (ISSN 0389-4010) (NAL-TR-1230) Avail: CASI HC A05/MF A01

Navigation systems have been tested with a Dornier 228-200 (Do228), experimental research airplane of the National Aerospace Laboratory (NAL) at Sendai airport, Japan. A C/A code single channel Global Positioning System (GPS) receiver (Rockwell/Collins Navcore 1) was installed in the Do228. The receiver can operate in real-time differential GPS (DGPS) during differential corrections coming from a GPS base station operated at a known position. The base station will track up to four visible satellites and measure the error in pseudo-range to each tracked satellite, based on broadcast ephemeris data and known position. A laser tracker was used to determine a reference trajectory of the airplane. Navigation accuracy of the onboard receiver is evaluated by direct comparison between reference trajectories and sensor outputs. Position accuracies of the GPS receiver are determined by pseudo-range errors between satellites and receiver. These ranging errors include common errors and receiver's specific residual errors. For all GPS receivers located within 200 kilometers of each other, common errors include satellite clock error, ephemeris error, refraction (ionospheric/tropospheric delay) and selective availability (SA) error. This paper describes GPS/DGPS accuracies during approach and landing of the aircraft. All data in which GDOP is less than five are divided into three cases: (1) stand-alone navigation with SA, (2) differential navigation with SA and (3) stand alone navigation without SA tested on January 1991. Stand-alone navigation accuracy under no SA is 20 meters, that is because the receiver's specific errors are

more than common errors. The effectiveness of DGPS under SA was demonstrated by flight experiments. Author

N95-26587*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FLIGHTPATH SYNTHESIS AND HUD SCALING FOR V/STOL TERMINAL AREA OPERATIONS (Diskette)
VERNON K. MERRICK and JAMES A. JESKE Apr. 1995 46 p
Diskette: 3.5-inch Mac diskette
(Contract(s)/Grant(s): RTOP 505-59-36)
(NASA-TM-110348; A-950052; NAS 1.15:110348; NONP-NASA-DK-95-48301) Avail: CASI SET A05 (HC,DK)

A two circle horizontal flightpath synthesis algorithm for Vertical/Short Takeoff and Landing (V/STOL) terminal area operations is presented. This algorithm provides a flightpath that is tangential to the aircraft's velocity vector at the instant of flightpath select and has continuous curvature. The algorithm corrects deficiencies noted in tests conducted with the V/STOL Systems Research Aircraft (VSRA) using a single circle algorithm described in NASA TM 104027. In addition, a more general vertical flightpath synthesis algorithm is presented, aimed primarily at minimizing the rapid increase of pilot workload during the final phase of decelerating transition just prior to acquiring the station-keeping point. Finally, a new technique for lateral scaling of a V/STOL Head Up Display (HUD) is presented, aimed at minimizing the inevitable anomalies that such scaling produces. All the above named items have been tested in flight with the VSVR, and all have produced improvements. Author

N95-26898 Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
ANALYSIS AND SIMULATION OF NARROWBAND GPS JAMMING USING DIGITAL EXCISION TEMPORAL FILTERING M.S. Thesis
GERALD L. FALEN Dec. 1994 187 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289328; AFIT/GE/ENG/94D-09) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The purpose of this thesis is to investigate the performance of the Digital Excision Temporal Filter (DETF) to reject narrowband jammers used against the Global Positioning System (GPS). The DETF takes the Fast Fourier Transform (FFT) of the GPS signal and excises any FFT bins that are above a preselected threshold level. Then the excised signal is Inverse Fourier Transformed and fed to the GPS receiver. Several jammer types are simulated including Continuous Wave (CW), Pulse CW, Swept CW, Narrowband Spot Noise, and Wideband Barrage Noise jammers. Cases are also simulated using all but the Wideband Barrage Noise jammer at one time. The DETF can effectively reject all of the types of jammers simulated except for the Wideband Barrage Noise jammer. The DETF degrades the GPS system performance in the presence of the Wideband Barrage Noise jammer. In an actual DETF implementation, the excision threshold should be set from six to nine dB above the excision cutoff level, where the excision cutoff level is equal to the GPS signal strength plus receiver thermal noise level. DTIC

N95-26978 Federal Aviation Administration, Atlantic City, NJ.
THE CONTROLLER MEMORY GUIDE. CONCEPTS FROM THE FIELD
EARL S. STEIN and JIM BAILEY Sep. 1994 44 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A289263; DOT/FAA/CT-TN94/28) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Memory is an elusive human ability which both helps and hinders air traffic controllers' performance. This document was developed based on the ideas of controllers themselves when they were asked what they did to manage their memory resources. The

guide is a job aide meant to help controllers think about what they do and about the little things they could use to help them reduce the possibilities for errors based on memory lapses. The material is presented in graphical cartoon format along with a very direct and minimalized text narrative. The goal was to provide the concepts in a readable format that controllers could review when they had the time. The issues covered in the guide all relate to memory in one way or another, but in many cases transcend memory issues alone, and look at the more basic issue of any person-machine system performance. Human and system performance are the bottom line in any complex command and control system such as air traffic control. DTIC

N95-26985 Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
AN INTEGRATED GPS/INS/BARO AND RADAR ALTIMETER SYSTEM FOR AIRCRAFT PRECISION APPROACH LANDINGS M.S. Thesis
ROBERT A. GRAY Dec. 1994 265 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289280; AFIT/GE/ENG/94D-13) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Currently, the Department of Defense (DOD) and the commercial airline industry are utilizing the Instrument Landing System (ILS) during aircraft landings for precision approaches. The replacement system for the aging ILS was thought to be the Microwave Landing System (MLS). Instead, use of the Global Positioning System (GPS) is now thought to be a viable replacement for ILS precision approaches. The majority of current precision landing research has exploited 'stand-alone' GPS receiver techniques. This thesis instead explores the possibilities of using an extended Kalman filter (EKF) that integrates an Inertial Navigation System (INS), GPS, Barometric Altimeter, Pseudolite and Radar Altimeter for aircraft precision approaches. This thesis shows that integrating the INS, GPS, Barometric Altimeter and Radar Altimeter meets Federal Aviation Administration (FAA) requirements for a Category I precision approach and integrating the INS, GPS, Barometric Altimeter, Radar Altimeter and a single Pseudolite meets FAA requirements for a Category 2 precision approach. DTIC

N95-27791*# Lockheed Martin Corp., Denver, CO. Management and Data Systems.
DETERMINING GPS AVERAGE PERFORMANCE METRICS Abstract Only
G. V. MOORE In NASA. Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium 1995 p 307 May 1995
Avail: CASI HC A01/MF A04

Analytic and semi-analytic methods are used to show that users of the GPS constellation can expect performance variations based on their location. Specifically, performance is shown to be a function of both altitude and latitude. These results stem from the fact that the GPS constellation is itself non-uniform. For example, GPS satellites are over four times as likely to be directly over Tierra del Fuego than over Hawaii or Singapore. Inevitable performance variations due to user location occur for ground, sea, air and space GPS users. These performance variations can be studied in an average relative sense. A semi-analytic tool which symmetrically allocates GPS satellite latitude belt dwell times among longitude points is used to compute average performance metrics. These metrics include average number of GPS vehicles visible, relative average accuracies in the radial, intrack and crosstrack (or radial, north/south, east/west) directions, and relative average PDOP or GDOP. The tool can be quickly changed to incorporate various user antenna obscuration models and various GPS constellation designs. Among other applications, tool results can be used in studies to: predict locations and geometries of best/worst case performance, design GPS constellations, determine optimal user antenna location and understand performance trends among various users. Author

N95-27903 Federal Aviation Administration, Atlanta, GA.
PRECISION LANDING SYSTEM MATHEMATICAL MODELING STUDY REPORT FOR ANDREWS AIR FORCE BASE, RUNWAY 19L, CAMP SPRINGS, MD Technical Note, Jun. - Jul. 1993

JESSE JONES, ELLIOTT RUSHTON, and RONALD LOCKHART
 Nov. 1994 129 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
 (AD-A289015; DOT/FAA/CT-TN93/35) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This technical note describes Microwave Landing System (MLS) and Precision Distance Equipment (DME/P) mathematical modeling performed for runway 19L, Andrews Air Force Base (ADW), Camp Springs, Maryland. This study evaluates the effects of scattering and shadowing from selected buildings, hangars, aircraft, and terrain. Results are provided as plots illustrating the predicted multipath levels, separation angles, and the resulting error plots from the worst case contributors. Scenarios were modeled to determine the effects of the multipath sources in the modeled environment. These resulting errors were analyzed and compared to error tolerance (FAA-STD-022d) to determine if the errors are acceptable. The effects of the ADW environment were analyzed and evaluated. It was determined that the proposed site will perform satisfactorily with no changes. DTIC

N95-28188* Technion Research and Development Foundation Ltd., Haifa (Israel). Dept. of Projects Promotion and R and D Administration.

ADVANCED INTERACTIVE DISPLAY FORMATS FOR TERMINAL AREA TRAFFIC CONTROL Semiannual

Progress Report, 1 Oct. 1994 - 31 Mar. 1995

ARTHUR J. GRUNWALD May 1995 38 p

(Contract(s)/Grant(s): NCCW-0045)

(NASA-CR-198576; NAS 1.26:198576) Avail: CASI HC A03/MF A01

The basic design considerations for perspective Air Traffic Control displays are described. A software framework has been developed for manual viewing parameter setting (MVPS) in preparation for continued, ongoing developments on automated viewing parameter setting (AVPS) schemes. The MVPS system is based on indirect manipulation of the viewing parameters. Requests for changes in viewing parameter setting are entered manually by the operator by moving viewing parameter manipulation pointers on the screen. The motion of these pointers, which are an integral part of the 3-D scene, is limited to the boundaries of screen. This arrangement has been chosen, in order to preserve the correspondence between the new and the old viewing parameter setting, a feature which contributes to preventing spatial disorientation of the operator. For all viewing operations, e.g. rotation, translation and ranging, the actual change is executed automatically by the system, through gradual transitions with an exponentially damped, sinusoidal velocity profile, in this work referred to as 'slewing' motions. The slewing functions, which eliminate discontinuities in the viewing parameter changes, are designed primarily for enhancing the operator's impression that he, or she, is dealing with an actually existing physical system, rather than an abstract computer generated scene. Current, ongoing efforts deal with the development of automated viewing parameter setting schemes. These schemes employ an optimization strategy, aimed at identifying the best possible vantage point, from which the Air Traffic Control scene can be viewed, for a given traffic situation. Author

N95-28540* Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.

DEVELOPMENT OF A CODING FORM FOR APPROACH CONTROL/PILOT VOICE COMMUNICATIONS Final Report

O. V. PRINZO, T. W. BRITTON, and A. M. HENDRIX (Hendrix, Alfred M., Carrizozo, NM.) May 1995 31 p

(Contract(s)/Grant(s): DTFA02-91-C-91089)

(DOT/FAA/AM-95/15) Avail: CASI HC A03/MF A01

The Aviation Topics Speech Acts Taxonomy (ATSAT) is a tool

for categorizing pilot/controller communications according to their purpose and for classifying communication errors. Air traffic controller communications that deviate from FAA Air Traffic Control Order 7110.65, and pilot communications that depart from the suggested communication in the Airman's Information Manual can be identified and labeled using the error codes provided in the ATSAT. By using the same procedures and tool to analyze communications, direct comparisons can be made between controller phraseology usage in the field and during simulation. Results of a preliminary study to measure inter-coder agreement revealed that novice coders were more dependent on the surface characteristics of the verbatim transcripts and experts relied more on domain specific background knowledge and experience with ATC phraseology to code ATC communications. If a researcher elects to use the ATSAT, we recommend that all coders receive the same orientation and instruction sessions prior to using it. Author

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A95-82482

A CONCEPTUAL DESIGN OF HYPERSONIC RESEARCH VEHICLE WITH SUBSCALE SCRAMJET ENGINE

KOICHI YONEMOTO Kawasaki Heavy Industries Ltd., Gifu, Japan, YOSHITSUGU KANNO Kawasaki Heavy Industries Ltd., Gifu, Japan, JUNICHIRO TOMIKE Kawasaki Heavy Industries Ltd., Kobe, Japan, and MASAYUKI NIINO National Aerospace Laboratory, Miyagi, Japan In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 1255-1262

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The National Aerospace Laboratory's (NAL) hypersonic flying test vehicle integrated with subscale scramjet engine has been studied from various viewpoints of an experimental scenario. The recent engineering target of the flight test emphasizes the engine performance at extremely high flight Mach number that can't be achieved by current wind tunnel test facilities. The design of the hypersonic vehicle becomes consequently more critical not only with regard to hypersonic aerodynamic design, precise navigation, guidance and robust control system, but also the thermal protection system and cooling. This paper describes the recent status of the conceptual study for the hypersonic subscale scramjet engine flight test. Author (Herner)

A95-82511

DEVELOPMENT AND FLIGHT RESULTS OF FIBER REINFORCED BALLOON

RYUJIRO AKIBA The Inst. of Space and Astronautical Science, Kanagawa, Japan, MOTOKI HINADA The Inst. of Space and Astronautical Science, Kanagawa, Japan, NOBUYUKI YAJIMA The Inst. of Space and Astronautical Science, Kanagawa, Japan, MASAMI FUJII The Inst. of Space and Astronautical Science, Kanagawa, Japan, YOSHIFUMI INATANI The Inst. of Space and Astronautical Science, Kanagawa, Japan, NOBUAKI ISHII The Inst. of Space and Astronautical Science, Kanagawa, Japan, NAOYUKI WATANABE Tokyo Metropolitan Inst. of Tech., Tokyo, Japan, KENSHI ODA Taiyo Kogyo Corp., Osaka, Japan, and SHINYA SEGAWA Taiyo Kogyo Corp., Osaka, Japan In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 1461-1466

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Since 1989, ISAS (the Institute of Space and Astronautical Science) has developed a tough balloon made of high-strength materials for the purpose of increasing reliability of balloons. From the results of strength tests of several kinds of materials both at a

normal temperature of 20 C and at a low temperature of -80 C, a high-strength fiber reinforced film (FRF) was selected for the balloon membrane. In order to verify manufacturing quality, small size balloons were experimentally constructed. Although FRF has a tensile strength high enough to remove load tapes for sustaining the total load, some overlapping of FRF at the top and the bottom part of the balloon is necessary. In order to examine the strength of critical parts, pressurized tests of the top parts and load tests of the bottom parts were conducted. In August, 1990, the FRF balloon of 5,000 cu cm in volume was constructed and a load test of the balloon fully inflated was performed. After the full inflation test in a large building, the actual flight of the identical balloon was successfully accomplished in the following September, and the total properties of the FRF balloon in a high altitude environment together with the mechanical functions of escape tubes and a tearing mechanism were examined. In September, 1991, the FRF balloon of 15,000 cu m in volume was launched from Sanriku Balloon Center (SBC). The balloon lifted a payload of 1.3 ton to an altitude of about 20 km to simulate the succeeding atmospheric re-entry flight test. A series of the verification tests had been completed, and the basic capability of the FRF balloon was sufficiently corroborated. In February, 1992, as a tentative goal of the development of the FRF balloon, the FRF balloon of 15,000 cu m in volume was applied to an atmospheric re-entry flight test using a winged space vehicle. The winged space vehicle was successfully launched by a solid propellant rocket motor from the balloon floating at around 18 km altitude. This paper describes the development process and the flight results of the FRF balloon.

Author (Herner)

A95-82512 RECENT DEVELOPMENTS IN NYLON SUPERPRESSURE BALLOONS

JAMES L. RAND Winzen International, Inc., San Antonio, TX, US, THOMAS M. LEW Winzen International, Inc., San Antonio, TX, US, and LOREN G. SEELY Winzen International, Inc., Sulphur Springs, TX, US *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 1467-1471 Copyright*

Nylon 6 biaxial oriented film has been available for some time in the United States of America. It is called Emblem film and has been used to build experimental superpressure balloons. Extensive design work has been done with stress analysis and property evaluation. Several methods of construction and various adhesive systems have been used. After a flight failure of a balloon based on the hot melt adhesive system, extensive tests were conducted on this system and some problems were noted. A new adhesive system was developed, along with a modification to the production equipment. Several balloons have been produced with the new system. This technology is reported on, along with flight results of the most recently built balloons.

Author (Herner)

A95-83489 AN INVERSE DESIGN METHOD OF TRANSONIC AIRFOIL AND WING

ZHU ZI-QIANG Beijing Univ., Beijing, China, XIA ZHI-XUM Beijing Univ., Beijing, China, and WU LI-YI Beijing Univ., Beijing, China *Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 6, no. 3 August 1993 p. 157-163 (HTN-95-71128) Copyright*

An inverse design method of transonic airfoil and wing is described, in which the following modifications are made for improving convergence and increasing application ability: an artificial viscosity term is added to the integral equation method to increase the ability of dealing with the shock; a Riegels type of leading edge correction is taken to remove the singularity at the leading edge of the round-nosed airfoil; a smoothing-relaxation procedure is proposed; all coefficients in the equations are integrated in the analytical form. A regularity condition in closed form for the transonic airfoils

is presented. A few design results indicate that this method is effective in the transonic airfoil and wing design. Author (Herner)

A95-83493 NON-LINEAR VISCOELASTIC-PLASTIC CONSTITUTIVE RELATIONS FOR AN AERONAUTICAL PMMA

XI-XIONG ZHU Ningbo Univ., Ningbo, China, GUO-RUI ZHU Ningbo Univ., Ningbo, China, and XU-SHENG HUANG Ningbo Univ., Ningbo, China *Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 6, no. 3 August 1993 p. 186-197 (HTN-95-71132) Copyright*

The uniaxial compression stress-strain curves of loading-unloading cycle in the ranges of $T = 40$ to approximately 40°C and $(\epsilon - \epsilon_{\text{sub}}) \cdot \dot{\epsilon} = 1.0 \times 10^{-4}$ to approximately 1.0×10^{-1} /s for glassy polymer polymethyl methacrylate (PMMA), and aeronautical perspex, have been experimentally measured. The characteristics of deformation behavior are discussed in more detail. A non-linear viscoelastic-plastic constitutive model, which is composed of an activation dashpot used to consider the plastic deformation in series couple with a standard linear solid or a Maxwell body used to consider the viscoelastic deformation, is provided. This model can consider the effects of both temperature and strain rate. The comprehensive constitutive equations both in differential and integral forms are provided. While using these equations to fit the experimentally measured stress-strain curves, the agreement is reasonably good. Finally, those characteristics of deformation behavior which can be rationally interpreted by the model of constitutive theory are enumerated and discussed.

Author (Herner)

A95-83494 THE ANALYSIS OF THE PROCESSING INCREASED WEIGHT FOR PILOT PRODUCTION OF F-X AIRCRAFT

MENG-ZHAO LIU Shenyang Aircraft Corporation, Shenyang, China and RUO-GANG PAN Shenyang Aircraft Corporation, Shenyang, China *Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 6, no. 3 August 1993 p. 198-204 (HTN-95-71133) Copyright*

Weight increment during aircraft preproduction is a persistent problem and attracts more manufactures' attention. Based on statistical analysis of calculated and actual weights of the parts of the F-X prototype empty aircraft in their manufacture classification and specialties, the critical components controlling weight increment of aircraft especially the fuselage and wing are presented; these parts are mainly machined, sheet-metal, casting part and cable. The main reason for weight increase in aircraft preproduction is that the dimension of most products is in the scope of their upper tolerance, but their nominal sizes are usually used in weight calculation. In addition, poor weight consciousness of some workers is also a factor not to be ignored, for example, over-tolerance occurring in some non-match parts.

Author (Herner)

A95-83655* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A HIGHER HARMONIC CONTROL TEST IN THE DNW TO REDUCE IMPULSIVE BVI NOISE

WOLFR. SPLETTSTOESSER DLR Research Center, Braunschweig, Germany, KLAUS-J. SCHULTZ DLR Research Center, Braunschweig, Germany, ROLAND KUBE DLR Research Center, Braunschweig, Germany, THOMAS F. BROOKS NASA. Langley Research Center, Hampton, VA, US, EARL R. BOOTH, JR. NASA. Langley Research Center, Hampton, VA, US, GEORG NIESL ECD Ottobrunn, Germany, and OLIVIER STREBY ECF Marignane, France *American Helicopter Society, Journal (ISSN 0002-8711) vol. 39, no. 4 October 1994 p. 3-13 (HTN-95-61071) Copyright*

A model rotor acoustic test was performed to examine the benefit of higher control (HHC) of blade pitch to reduce blade-vortex interaction (BVI) impulse noise. A 40-percent dynamically scaled, four-bladed model of a BO-105 main rotor was tested in the German-Dutch Wind Tunnel (DNW). Acoustic measurements were made in a large plane underneath the rotor employing a traversing in-flow

microphone array in the anechoic environment of the open test section. Noise characteristics and noise directivity patterns as well as vibratory loads were measured and used to demonstrate the changes when different HHC schedules (different modes, amplitudes, phases) were applied. Dramatic changes of the acoustic signatures and the noise radiation directivity with HHC phase variations are found. Compared to the baseline conditions (without HHD), significant mid-frequency noise reductions of as much as 6 dB are obtained for low speed descent conditions where BVI is most intensive. For other rotor operating conditions with less intense BVI there is less or no benefit from the use of HHC. Low frequency loading noise and vibratory loads, especially at optimum noise reduction control settings, are found to increase. Author (Hemer)

A95-84031

EUROPEAN FIRMS TEAM ON SUPERSONIC STUDIES

PIERRE SPARACO and CAROLE A. SHIFRIN Aviation Week and Space Technology (ISSN 0005-2175) vol. 140, no. 15 April 11, 1994 p. 20-21
(HTN-95-42215) Copyright

Aerospatiale, British Aerospace, and Deutsche Aerospace are establishing a joint technology program for a new-generation supersonic transport. This article discusses the baseline configuration, capable of carrying 250 passengers over 10,000 km at Mach 2.

Hemer

A95-84554

CHARLES NORVIN RINEK; AN EARLY AMERICAN PIONEER IN ADVANCED AVIATION ENGINES

LARRY M. RINEK SRI International, US In Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993. A95-84553 Warrendale, PA Society of Automotive Engineers, Inc. 1993 p. 1-14
(SAE PAPER 930485) Copyright

Charles Norvin Rinek (1888-1890), one of America's largely unknown aviation pioneers, built and flew some innovative engines. His principal contribution to aeronautical engineering was a series of pre-World War 1 engines (mainly water-cooled 4-stroke V-8s) that exhibited advanced construction materials, relatively light weight, enhanced reliability, and clever mechanical features. He also manufactured wood propellers of sophisticated design and built and flew a test-bed aircraft. He modified this 1909 pusher biplane design from a basic French 1908 Voisin, successfully using new and advanced engineering materials, such as chrome-moly alloy steel tubing. His engineering work has been displayed at a few prominent aeronautical museums, including the Smithsonian National Air and Space Museum. Author (Hemer)

A95-84555

FLYING QUALITIES DEVELOPMENT AND FLIGHT SIMULATION EVALUATION OF THE TW-68 TILT-WING VTOL AIRCRAFT

DWAYNE F. KIMBALL Ishida Aerospace Research, Inc., Dallas, TX, US Warrendale, PA Society of Automotive Engineers, Inc. aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993 1993 p. 15-28
(SAE PAPER 932517) Copyright

The TW-68 is a civil tilt-wing aircraft proposed by the Ishida Group. Flight simulation was applied to develop the flying qualities of this design. The simulation was accomplished using a mathematical model specially created for this purpose. The effort culminated in piloted evaluations purpose. The effort culminated in piloted evaluations of the simulated aircraft's flight characteristics in a variety of representative mission tasks, both with and without the augmentation of a core Automatic Flight Control System. The paper describes the mathematical model, simulation experiments and results. Flight control laws and their development are also discussed, as are the predicted flight capabilities and limitations of the TW-68. Author (Hemer)

A95-84556

HUMAN FACTORS ISSUES IN AIRCRAFT CABIN DESIGN

SALLY MOORE Douglas Aircraft Co., US, NOREEN MCQUINN

Douglas Aircraft Co., US, and RANDI ROHRER Douglas Aircraft Co., US In Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993. A95-84553 Warrendale, PA Society of Automotive Engineers, Inc. (ISSN) 1993 p. 29-35
(SAE PAPER 932527) Copyright

This paper discusses the techniques and technologies Human Factors uses to incorporate safety, comfort, and advancing technologies in the aircraft cabin. Specific topics addressed include accommodation for various user populations (e.g., reach, clearances, lifting), operation of required equipment, information transfer, passenger comfort and convenience, as well as passenger and flight attendant behavioral issues. The content includes a review of typical human-cabin interface case studies. These design projects include a description of the multiple-design requirements that cabin enhancements must meet. Finally, the paper includes a description of on-going efforts to increase the extent and quality of the human-aircraft cabin interface. Author (Hemer)

A95-84558

INTELLIGENT FLIGHT TRAINER FOR INITIAL ROTARY WING TRAINING

GREG L. ZACHARIAS Charles River Analytics, Inc., Cambridge, MA, US, EDWARD W. RILEY Charles River Analytics, Inc., Cambridge, MA, US, PAUL G. GONSALVES Charles River Analytics, Inc., Cambridge, MA, US, and JACK A. DOHME Army Research Inst. Research and Development Activity, Fort Rucker, AL, US In Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993. A95-84553 Warrendale, PA Society of Automotive Engineers, Inc. (ISSN) 1993 p. 49-61

(Contract(s)/Grant(s): MDA903-92-C-0047)

(SAE PAPER 932536) Copyright

This paper summarizes an effort to develop and demonstrate an Intelligent Flight Trainer (IFT) for Initial Entry Rotary Wing (IERW) training. Demonstration of concept feasibility relies on an Intelligent Tutoring System (ITS) architecture incorporating adaptive training to progressively improve student pilot proficiency. The IFT structure includes: a teacher model which includes algorithmic and expert system assessments of student performance; a domain expert model which maintains knowledge of maneuver criteria and strategies; and a student model which reflects student proficiency. Under an initial feasibility effort we implemented the IFT, integrated it with the UH-1 Training Research Simulator (UH-1TRS) at Fort Rucker, and demonstrated real-time operation in teaching student pilots elementary hover maneuvers. Follow-on development and validation will extend the IFT to a full-scope IERW trainer, validate its effectiveness, and specify requirements for developing it into an add-on modules for existing simulators. Author (Hemer)

A95-85212

THE SHORT RANGE ATTACK MISSILE/LIGHT WEIGHT EXO-ATMOSPHERIC PROJECTILE (SRAM/LEAP) MISSILE TESTS PROGRAM

M. MOORE SPARTA, Inc., Lancaster, CA, US Cockpit (ISSN 0742-1508) July/August/September 1994 p. 4-11
(HTN-95-81498) Copyright

The Air Force Air Staff has tasked the Strategic Defense Initiative Office (SDIO) to demonstrate the capability of Theatre Missile Defense (TMD). This Short Range Attack Missile (SRAM) Technology paper will discuss the coordinated planning required for the flight test program, and will describe the mission objectives, success criteria, hardware configurations, integration devices, and test reporting. This paper will concentrate on phase 1 of the technology demonstration test program that consists of four launches of SRAM-A missiles from a B-52 aircraft in the next fourteen months. Author (revised by Hemer)

A95-85213

T-45A HIGH ANGLE ATTACK TESTING

J. A. FERGIONE Lockheed, Fort Worth, TX, US Cockpit (ISSN

0742-1508) July/August/September 1994 p. 5-24
(HTN-95-81499) Copyright

Late in 1993, the T-45A completed the High Angle of Attack testing as part of its Full Scale Development program. That testing involved upright and inverted spins in both the clean wing and the asymmetric stores configurations. Follow-on testing of the T-45's High Angle of Attack (HAOA) characteristics by the NAVY was completed late September 1994. Understanding exactly how and why an aircraft departs controlled flight and then gyrates and/or spins the way it does is a fascinating science. While the T-45 has generally conventional HAOA flying qualities, the HAOA flying qualities, in some areas, could be considered unconventional. Examples would be the apparent lack of a sustainable upright spin mode, unstable lateral stability at negative angles of attack, and the very high departure resistance at positive angles of attack. Also of interest is the interplay between the various inverted out of control modes. Flight testing of the above areas proved to be the most challenging and are presented here along with lessons learned during the program. Author (Hemer)

A95-85356

CONDITION MONITORING AND DIAGNOSTICS

DOUGLAS MUSTER and RONALD W. CAULKINS Aerospace Engineering (ISSN 0736-2536) vol. 15, no. 1 January-February 1995 p. 25-26

(HTN-95-92312) Copyright

Engineers are employing condition monitoring and diagnostics to detect faults, maintain conditions within certain limits, predict probable future behavior, and improve the future design of aircraft and their subsystems. Condition monitoring and diagnostics of machines contains subfields, which include balancing, vibrations, acoustics, performance management, maintenance management, long-term behavior prediction, lubrication, fault detection, sensor-based instrumentation, and data handling. Condition monitoring has been used on helicopters for vibration monitoring for years. An example that illustrates the use of condition monitoring for helicopters is the OH-58D helicopter, and this example is described in this paper. Hemer

A95-85491

VARIATIONAL PRINCIPLES FOR ASCENT SHAPES OF LARGE SCIENTIFIC BALLOONS

FRANK BAGINSKI George Washington Univ, Washington, DC, United States and SITA RAMAMURTI AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 764-768 refs
(BTN-95-EIX95262694320) Copyright

Current mathematical models of large scientific balloons assume an axisymmetric ascent shape, sharply contrasting what is observed in real balloons. We propose an approach to computing nonaxisymmetric shapes of balloons which is based on the inextensibility of certain balloon fibers and a set of rules that model how excess material must fold away. The energy of a balloon configuration is modeled as the sum of the gravitational potentials of the lifting gas and balloon fabric. We evolve an initial guess to a shape that minimizes this energy while satisfying certain material constraints. We refer to a shape determined in this fashion as an energy-minimizing (EM) shape. Using our approach to compute axisymmetric EM shapes, we find our results agree with those obtained by solving the standard summation-shape model. For nonaxisymmetric shapes, we are able to compute shapes that possess features observed in actual balloons, including internally folded material, flat wing sections, and periodic lobe-like structures surrounding the gas bubble. Author (EI)

A95-85892

FATIGUE OF AIRCRAFT MATERIALS; SPECIALISTS' CONFERENCE, DELFT, NETHERLANDS, 1992

International Journal of Fatigue (ISSN 0142-1123) vol. 16, no. 1 January 1994 96 p.

(HTN-95-B0076) Copyright

A conference on the fatigue of aircraft materials concentrated

on the following areas: fatigue of metallic materials; fatigue of fiber-metal laminates; fatigue and composites; and fatigue and airworthiness. For individual titles, see A95-85893 through A95-85898.

Hemer

A95-85893

STATUS AND PROSPECTS FOR ALUMINIUM-LITHIUM ALLOYS IN AIRCRAFT STRUCTURES

R. J. H. WANHILL National Aerospace Laboratory, NLR, The Netherlands Fatigue of aircraft materials; Specialists' Conference, Delft, Netherlands, 1992. A95-85892 International Journal of Fatigue (ISSN 0142-1123) vol. 16, no. 1 January 1994 p. 3-20 Copyright

This paper examines the status and prospects for widespread application of Al-Li alloys in aircraft structures. Particular attention is paid to the damage tolerance engineering properties of fatigue crack growth and fracture. At present the application of Al-Li alloys is very limited. This is because they are not direct replacements for conventional alloys and the basic material costs are usually too high. Widespread application of Al-Li alloys may well require a new generation of alloys, especially for primary structures. This will take at least five years. In the meantime, experience will be gained by selective application of the current generation of Al-Li alloys in secondary structures. Author (Hemer)

A95-85894

FATIGUE OF AIRCRAFT MATERIALS AND STRUCTURES

J. SCHIJVE Delft University of Technology, The Netherlands Fatigue of aircraft materials; Specialists' Conference, Delft, Netherlands, 1992. A95-85892 International Journal of Fatigue (ISSN 0142-1123) vol. 16, no. 1 January 1994 p. 21-31 Copyright

The paper starts with a survey of some aircraft fatigue accidents, which have significantly affected ideas about fatigue requirements for aircraft structures and materials. Contributions of fatigue research are focused on the meaning of fatigue under variable-amplitude loading for full-scale fatigue tests, and fatigue of riveted joints in relation to aging aircraft. The new fiber-metal laminates (ARALL and GLARE) are briefly introduced with reference to structural applications. The paper is completed with a discussion on different design options to improve the fatigue resistance of aircraft structures. Author (Hemer)

A95-85895

FIBRE-METAL LAMINATES

G. H. J. J. ROEBROEKS Structural Laminates Company, The Netherlands Fatigue of aircraft materials; Specialists' Conference, Delft, Netherlands, 1992. A95-85892 International Journal of Fatigue (ISSN 0142-1123) vol. 16, no. 1 January 1994 p. 33-42 Copyright

Fiber-metal laminates are an attractive alternative for monolithic aluminum alloys in primary aircraft structures. The fatigue crack initiation behavior and fatigue crack growth behavior of laminates in joints under realistic loading conditions are superior to those of aluminum alloys. The damage tolerance of GLARE structures is significantly better than that of aluminum alloys. The superior behavior of laminates can be translated into weight savings in aircraft structures, combined with cost savings in production. However, fiber-metal laminates could be the only option from a safety standpoint for large parts of the new generation of large aircraft. A new design philosophy based on an increased level of safety compared with today's standards (focusing on fire resistance and improved damage tolerance and inspectability) might require the use of laminates. Author (revised by Hemer)

A95-85896

ELEMENTS OF STRUCTURAL INTEGRITY ASSURANCE

ULF G. GORANSON Boeing Commercial Airplane Group, Seattle, Washington, US Fatigue of aircraft materials; Specialists' Conference, Delft, Netherlands, 1992. A95-85892 International Journal of Fatigue (ISSN 0142-1123) vol. 16, no. 1 January 1994

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

p. 43-65
Copyright

Boeing initiated the Structures Durability Program 20 years ago in response to increased fatigue performance demands of transport aircraft. The program was a major step in experience retention and formulation of an engineering approach to fatigue detail design. Subsequently, technology standards have evolved for sonic fatigue, crack growth, residual strength and structural maintenance planning. Lessons from service experience, component and major test articles, structural teardowns and fleet survey programs have resulted in several updates of technology standards employed by structures engineers who do not specialize in fatigue and fracture evaluations. This paper provides a perspective view on this evolution and lessons learned. Author (revised by Hemer)

A95-85897

VERIFICATION OF THE DAMAGE TOLERANCE OF A FIGHTER AIRCRAFT

L. JARFALL Saab Military Aircraft, Linköping, Sweden Fatigue of aircraft materials; Specialists' Conference, Delft, Netherlands, 1992. A95-85892 International Journal of Fatigue (ISSN 0142-1123) vol. 16, no. 1 January 1994 p. 67-74
Copyright

This paper defines the policy applied by Saab Military Aircraft for the damage tolerance verification of the JAS39 Gripen aircraft. The paramount feature of the Saab verification policy is that the verification test shall be carried out with series production parts correctly built into their adjacent structure. A consequence of this is that the Saab verification policy is dependent upon the characteristics of artificial flaws; time to initiation of a natural fatigue crack, and its dependence upon variations in the flaw-manufacturing process. Supporting research programs have proved that the artificial flaw issue is no cause for concern. Finally, 12 completed damage tolerance verification tests on structural assemblies are briefly reviewed. Author (revised by Hemer)

A95-85898

DAMAGE TOLERANCE CAPABILITY

T. SWIFT Federal Aviation Administration, Long Beach, California, US Fatigue of aircraft materials; Specialists' Conference, Delft, Netherlands, 1992. A95-85892 International Journal of Fatigue (ISSN 0142-1123) vol. 16, no. 1 January 1994 p. 75-94
Copyright

The purpose of this paper is to encourage manufacturers of future transport aircraft to retain the large damage-tolerance capability designed into the first wide-bodied aircraft and to modify their methodology to establish inspection thresholds for those structures incapable of sustaining large obviously detectable damage. Author (revised by Hemer)

N95-26389 Defence Science and Technology Organisation, Melbourne (Australia). Aeronautical and Maritime Research Lab. F/A-18 IFOSTP FATIGUE TEST AIRBAG LOAD DETERMINATION ON THE VERTICAL AND HORIZONTAL TAILS

M. F. LEE Jan. 1995 54 p
(DSTO-TR-0135; AR-009-193) Copyright Avail: Issuing Activity (DSTO, Melbourne Victoria, Australia)

A simplistic method for determining discrete loads to approximate a distributed load is shown to have a number of deficiencies, both theoretically and in its practical results. A new method which utilizes Lagrange multipliers is derived and applied to an aerodynamic pressure distribution with improved results. The concept of weighting functions is introduced as a means of comparing the different methods in absolute terms. Weighting functions are also used to assess the effect of removing a load actuator from the standard configuration. Author

N95-26481 Air Force Inst. of Tech., Wright-Patterson AFB, OH. DEVELOPMENT OF A NONLINEAR SIMULATION FOR THE MCDONNELL DOUGLAS F-15 EAGLE WITH A

LONGITUDINAL TECS CONTROL-LAW M.S. Thesis - Washington Univ.

JAMES P. DUTTON, JR. Sep. 1994 158 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A288610; AFIT/CI/CIA/94-136) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The purpose of this report is to develop using SIMULINK an aircraft simulation that couples the nonlinear equations of motion with the nonlinear aerodynamic and engine performance data. The simulation has been designed using data from actual flight testing of the McDonnell Douglas E-15 Eagle. The ultimate objective is to provide a generic framework for the development of nonlinear simulations of other aircraft with minimal required changes. Design of a longitudinal autopilot using the Total Energy Control System (TECS) concept is accomplished using the linearized model and later validated with the nonlinear model. The model characteristics and the relevant support modules for the F-15 described in are summarized. The numerical data were provided in the format of a Genesis simulation used at Wright-Patterson and the coding was subsequently converted from FORTRAN to MATLAB. A detailed description of the model is in Chapter 2. The evaluation of the open-loop nonlinear model and the design of the TECS control law will be accomplished at the two flight points. Other flight conditions throughout the flight envelope will also be investigated. DTIC

N95-26507 Department of the Navy, Washington, DC.

SUPPRESSOR OF OSCILLATIONS IN AIRFRAME CAVITIES Patent

ROBERT A. SMITH, inventor (to Navy), EPHRAIM GUTMARK, inventor (to Navy), KLAUS C. SCHADOW, inventor (to Navy), and KENNETH J. WILSON, inventor (to Navy) 23 Aug. 1994 8 p Filed 14 Feb. 1992

(AD-D017265; US-PATENT-5,340,054; US-PATENT-APPL-SN-839721; US-PATENT-CLASS-244-1) Avail: US Patent and Trademark Office

The oscillations found to occur in the cavities of a structural frame moving through a fluid are substantially eliminated by the adoption of perturbation elements located at the leading edge of the cavity and reflecting any remaining oscillations out of the cavity at the trailing edge. The perturbation elements may take the form of multiple pins of various shape and geometrical arrangement which prevents the generation and growth of vortices causing acoustic oscillations. The reflection of remaining oscillations out of the cavity may be accomplished by ramping the trailing edge of the cavity. DTIC

N95-26525# National Aerospace Lab., Tokyo (Japan). Advanced Aircraft Research Group.

EXPERIMENTAL INVESTIGATION OF STATIC AND DYNAMIC GROUND EFFECT ON HOPE ALFLEX VEHICLE

MASASHI SHIGEMI, AKIHITO IWASAKI, KENICHI RINOIE, TOSHIMI FUJITA, TAKESHI OHNUKI, HIDEHIKO NAKAYASU (National Space Development Agency, Tokyo, Japan.), and MASAKAZU SAGISAKA (National Space Development Agency, Tokyo, Japan.) May 1994 59 p In JAPANESE (ISSN 0389-4010)

(NAL-TR-1236) Avail: CASI HC A04/MF A01

A wind tunnel test was conducted to investigate the ground effect on an 8.9% model of the ALFLEX vehicle. The objectives of this experiment were: (1) to make a preliminary inspection of the influence of the new model supporting system on the main flow; (2) to collect data of the static ground effect; and (3) to collect data of the dynamic ground effect. A robot designed for general industrial use was employed as a tool for model support. The model equipped at the tip of the robot arm could be controlled to change its position as well as its pitch, roll and yaw angles. The merits of utilizing the robot in our experiment was not only to raise the efficiency of the static measurements but also to make it possible to collect the dynamic data in the ground effect test. Comparison between results from static and dynamic tests showed that the amount of the dynamic ground effect is no more than the static effect. Author

N95-26537 Department of the Navy, Washington, DC.
BALANCED ON AIR AIRCRAFT Patent Application
 JOHN REEVES, inventor (to Navy) 21 Jul. 1994 8 p Limited
 Reproducibility: More than 20% of this document may be affected by
 microfiche quality
 (AD-D017251; US-PATENT-APPL-SN-010986) Avail: Issuing Ac-
 tivity (Defense Technical Information Center (DTIC))

This patent application concerns the development of a new
 design for a Balance on Air Aircraft. CASI

N95-26590* MCAT Inst., San Jose, CA.
AEROELASTICITY OF WING AND WING-BODY
CONFIGURATIONS ON PARALLEL COMPUTERS Final
Report, Feb. 1992 - Jan. 1995
 CHANSUP BYUN Jan. 1995 24 p Original contains color
 illustrations
 (Contract(s)/Grant(s): NCC2-740)
 (NASA-CR-197756; NAS 1.26:197756; MCAT-95-14) Avail: CASI
 HC A03/MF A01; 7 functional color pages

The objective of this research is to develop computationally
 efficient methods for solving aeroelasticity problems on parallel
 computers. Both uncoupled and coupled methods are studied in this
 research. For the uncoupled approach, the conventional U-g method
 is used to determine the flutter boundary. The generalized aerody-
 namic forces required are obtained by the pulse transfer-function
 analysis method. For the coupled approach, the fluid-structure
 interaction is obtained by directly coupling finite difference Euler/
 Navier-Stokes equations for fluids and finite element dynamics
 equations for structures. This capability will significantly impact
 many aerospace projects of national importance such as Advanced
 Subsonic Civil Transport (ASCT), where the structural stability
 margin becomes very critical at the transonic region. This research
 effort will have direct impact on the High Performance Computing
 and Communication (HPCC) Program of NASA in the area of parallel
 computing. Derived from text

N95-26591* MCAT Inst., San Jose, CA.
COMPUTATIONAL ANALYSIS OF FOREBODY TANGENTIAL
SLOT BLOWING ON THE HIGH ALPHA RESEARCH
VEHICLE Final Report
 KEN GEE Jan. 1995 57 p Original contains color illustrations
 (Contract(s)/Grant(s): NCC2-657)
 (NASA-CR-197754; NAS 1.26:197754; MCAT-95-11) Avail: CASI
 HC A04/MF A01; 1 functional color page

A numerical analysis of forebody tangential slot blowing as a
 means of generating side force and yawing moment is conducted
 using an aircraft geometry. The Reynolds-averaged, thin-layer,
 Navier-Stokes equations are solved using a partially flux-split,
 approximately-factored algorithm. An algebraic turbulence model is
 used to determine the turbulent eddy viscosity values. Solutions are
 obtained using both patched and overset grid systems. In the
 patched grid model, and actuator plane is used to introduce jet
 variables into the flow field. The overset grid model is used to model
 the physical slot geometry and facilitate modeling of the full aircraft
 configuration. A slot optimization study indicates that a short slot
 located close to the nose of the aircraft provided the most side force
 and yawing moment per unit blowing coefficient. Comparison of
 computed surface pressure with that obtained in full-scale wind
 tunnel tests produce good agreement, indicating the numerical
 method and grid system used in the study are valid. Full aircraft
 computations resolve the changes in vortex burst point due to
 blowing. A time-accurate full-aircraft solution shows the effect of
 blowing on the changes in the frequency of the aerodynamic loads
 over the vertical tails. A study of the effects of freestream Mach
 number and various jet parameters indicates blowing remains
 effective through the transonic Mach range. An investigation of the
 force onset time lag associated with forebody blowing shows the lag
 to be minimal. The knowledge obtained in this study may be applied
 to the design of a forebody tangential slot blowing system for use on
 flight aircraft. Author

N95-26651* MCAT Inst., San Jose, CA.
DESIGN AND TESTING OF LOW SONIC BOOM
CONFIGURATIONS AND AN OBLIQUE ALL-WING
SUPERSONIC TRANSPORT Final Report, Dec. 1991 - Jan.
1995
 CHRISTOPHER A. LEE Feb. 1995 7 p Original contains color
 illustrations
 (Contract(s)/Grant(s): NCC2-617)
 (NASA-CR-197744; NAS 1.26:197744; MCAT-95-07) Avail: CASI
 HC A02/MF A01; 1 functional color page

From December 1991 to June 1992, applied aerodynamic
 research support was given to the team working on Low Sonic Boom
 configurations in the RAC branch at NASA Ames Research Center.
 This team developed two different configurations: a conventional
 wing-tail and a canard wing, in an effort to reduce the overpressure
 of shock waves and the accompanying noise which are projected to
 the ground from supersonic civil transport aircraft. A generic descrip-
 tion of this sensitive technology is given. Derived from text

N95-26652 Naval Postgraduate School, Monterey, CA.
COMPARISON OF FIXED WING AIRCRAFT ALGORITHMS
FOR JANUS M.S. Thesis
 CHARLES L. DANIELS, II Sep. 1994 85 p Limited Reproducibility:
 More than 20% of this document may be affected by microfiche
 quality
 (AD-A288503) Avail: Issuing Activity (Defense Technical Informa-
 tion Center (DTIC))

This research compares the fixed wing altitude algorithms
 utilized in the United States and the Australian versions of the
 combat modeling tool, JANUS(A). The Australian Army Battle Simu-
 lation Group has recently developed a new algorithm that more
 realistically models aircraft flight profiles within JANUS(A). A Low-
 High-Low strike profile was simulated, using both algorithms, against
 low level, littoral anti-aircraft weaponry. The simulated aircraft were
 flown in a weapons hold environment and number of detections were
 recorded over the entire strike route as the principal MOE. The
 simulated aircraft were then subjected to a weapons free environ-
 ment where engagement data was compiled. The Australian algo-
 rithm enabled the operator to alter aircraft altitude and speed during
 the simulation on command. The ability to alter altitude and speed
 are essential to accurately modelling tactical evasive maneuvers.
 These alterations are not features incorporated in the present U.S.
 version of JANUS(A). Analysis indicates this controllability not only
 reduced the number of detections significantly, but also increased
 aircraft survivability within the strike environment. Both of these
 phenomenon are expected outcomes of such evasive actions. This
 work also provided the basis for future work that could incorporate
 virtual simulation with JANUS(A). DTIC

N95-26684 Veda, Inc., Dayton, OH.
INTEGRATED MISSION PRECISION ATTACK COCKPIT
TECHNOLOGY (IMPACT). PHASE 1: IDENTIFYING
TECHNOLOGIES FOR AIR-TO-GROUND FIGHTER
INTEGRATION Final Report, 1 Apr. 1993 - 11 May 1994
 ANTHONY J. MONTECALVO, MARK C. REDDEN, EVAN P.
 ROLEK, HORACE A. ORR, and GREGORY J. BARBATO 31 Oct.
 1994 126 p Limited Reproducibility: More than 20% of this
 document may be affected by microfiche quality
 (Contract(s)/Grant(s): F33615-93-D-3800)
 (AD-A289562; WL-TR-94-3143) Avail: Issuing Activity (Defense
 Technical Information Center (DTIC))

The Integrated Mission Precision Attack Cockpit Technology
 (IMPACT) Program focuses on the analysis, design, and test of
 cockpit control and display concepts for a single seat, multirole
 fighter performing precision strike missions against mobile and fixed
 targets, at night and in adverse weather. This report details the
 results of the first 'role playing' exercise. This was an exploratory
 evaluation assessing: (1) pilot workload associated with an air
 interdiction mission in a single seat fighter; and (2) advanced
 technologies having the potential to reduce workload and increase

mission effectiveness. Subjective workload measures were collected for a baseline F-15E, conceptual single-seat F-15E, and an Advanced Technology Cockpit (ATC) using the Subjective Workload Assessment Technique (SWAT) and Subjective Workload Dominance (SWORD) technique. Advanced technologies, assumed to be in use in the year 2005, and their possible mechanizations, were rated using questionnaires and interviews. This report describes the role playing methodology and the test results. DTIC

N95-26813* MCAT Inst., San Jose, CA.

SUPERSONIC CIVIL AIRPLANE STUDY AND DESIGN:

PERFORMANCE AND SONIC BOOM Final Report, Jul. 1989 - Jan. 1995

SAMSON CHEUNG Jan. 1995 117 p Original contains color illustrations

(Contract(s)/Grant(s): NCC2-617)

(NASA-CR-197745; NAS 1.26:197745; MCAT-95-7) Avail: CASI HC A06/MF A02; 11 functional color pages

Since aircraft configuration plays an important role in aerodynamic performance and sonic boom shape, the configuration of the next generation supersonic civil transport has to be tailored to meet high aerodynamic performance and low sonic boom requirements. Computational fluid dynamics (CFD) can be used to design airplanes to meet these dual objectives. The work and results in this report are used to support NASA's High Speed Research Program (HSRP). CFD tools and techniques have been developed for general usages of sonic boom propagation study and aerodynamic design. Parallel to the research effort on sonic boom extrapolation, CFD flow solvers have been coupled with a numeric optimization tool to form a design package for aircraft configuration. This CFD optimization package has been applied to configuration design on a low-boom concept and an oblique all-wing concept. A nonlinear unconstrained optimizer for Parallel Virtual Machine has been developed for aerodynamic design and study. Derived from text

N95-26844 Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

A COMPARISON OF THE NEAL-SMITH AND OMEGA TAU FUNCTION, ZETA FUNCTION AND TAU FUNCTION FLYING QUALITIES CRITERIA M.S. Thesis

BRIAN A. KISH Dec. 1994 145 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289503; AFIT/GAE/ENY/94D-11) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Aircraft pitch response is a vital element of piloted vehicle flying qualities. There has been controversy over both the form and the substance of the requirements for short-term pitch response. Currently, MIL-STD-1797A offers six different methods for evaluating short-term pitch response. These six methods often give conflicting results. Two methods are analyzed in this thesis - the Neal-Smith criteria and the omega(sub sp) Tau(sub theta 2), zeta(sub sp), tau(sub theta) criteria. Domains from both criteria are mapped into each other identifying regions of conflict and regions of agreement. Parametric studies are performed and evaluated for trends. Further, a real-time analysis tool for evaluating these methods is developed. DTIC

N95-26873 Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

AN ANALYSIS OF THE KC-135 THREE-PERSON COCKPIT M.S. Thesis

ROBERT A. DEIVERT Dec. 1994 66 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289540; AFIT/GSO/ENS/94D-06) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

In an effort to quantitatively determine the utility of mission effectiveness of the KC-135, this research used value-focused thinking to measure the impact of replacing the KC-135 navigator with upgraded avionics. A value model was developed as a hierar-

chy with fundamental objectives at the highest level and attributes at the lowest level. Weights were assigned to show the contribution each level had to the one above it. The attributes were given a score and an additive model was used to determine utility with and without a navigator. Break-even analysis and net present value calculations were done to show the costs associated with each alternative. This study reveals that the cockpit with the navigator has a higher utility than the cockpit with the upgraded avionics. Value-focused thinking identified additional equipment that would increase the utility of the upgraded avionics. This approach can be used to identify equipment alternatives in the future that add the most utility. This methodology can be used by the Air National Guard to determine whether they should keep navigators as part of the KC-135 crew. DTIC

N95-26876 Air Force Inst. of Tech., Wright-Patterson AFB, OH.

THE PHOTO-REALISTIC AFIT VIRTUAL COCKPIT M.S. Thesis

MILTON E. DIAZ Dec. 1994 115 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289376; AFIT/GCS/ENG/94D-02) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The Air Force Institute of Technology (AFIT) has pursued research in virtual environments since 1988. This research expands the current capabilities of the AFIT Virtual Cockpit (VC) by increasing the realism of the cockpit environment and improving the pilot's command interface. Realism is improved creating console elements from texture maps and polygonal models; these elements include working dials, switches and circuit breakers. The pilot command interface is improved in part by adapting the AFIT Information Pod using a two-dimensional mouse input to the virtual three-dimensional environment. This immersive virtual environment is also improved by modifications to the Head Mounted Display (HMD) reducing jitter and allowing the simulation pilot to adjust his/her position within the cockpit. DTIC

N95-26942* Kansas Univ., Lawrence, KS.

PRELIMINARY DESIGN PROBLEMS AND SOLUTIONS FOR A SUPERSONIC OBLIQUE ALL-WING TRANSPORT AIRCRAFT Abstract only

TROY DOWNEN In Wichita State Univ., AIAA Techfest 20 Proceedings 2 p 1994

Avail: CASI HC A01/MF A03

Although the oblique all-wing transport (OAWT) has been studied in some detail for the last twenty years, some of the most basic design features of such aircraft have not received much attention. Due to the unique configuration of the OAWT, passenger ingress/egress and cargo loading will present problems, as will the internal cabin arrangement, engine placement and take-off attitude. This presentation examines the nature of these preliminary design problems and proposes one or more viable solutions for each. Author

N95-26945* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THE HIGH SPEED CIVIL TRANSPORT AND NASA'S HIGH SPEED RESEARCH (HSR) PROGRAM Abstract only

ROBERT J. SHAW In Wichita State Univ., AIAA Techfest 20 Proceedings 2 p 1994

Avail: CASI HC A01/MF A03

Ongoing studies being conducted not only in this country but in Europe and Asia suggest that a second generation supersonic transport, or High-Speed Civil Transport (HSCT), could become an important part of the 21st century international air transportation system. However, major environmental compatibility and economic viability issues must be resolved if the HSCT is to become a reality. This talk will overview the NASA High-Speed Research (HSR) program which is aimed at providing the U.S. industry with a technology base to allow them to consider launching an HSCT program early in the next century. The talk will also discuss some of the comparable activities going on within Europe and Japan. Author

**N95-26947# Kansas Univ., Lawrence, KS.
DESIGN OF A HIGH ALTITUDE LONG ENDURANCE
AIRCRAFT WITH MANUFACTURING CONSIDERATIONS
Abstract Only**

CATHERINE GRANT, RICHARD HAZLEWOOD, HOWARD SACKS,
and TROY DOWNEN *In* Wichita State Univ., AIAA Techfest 20
Proceedings 2 p 1994

Avail: CASI HC A01/MF A03

There is a current need for a low cost, low maintenance, unmanned High Altitude Long Endurance (HALE) aircraft to conduct high altitude atmospheric studies. Future military applications are possible. The preliminary design of a HALE vehicle is presented with special attention to low cost (low maintenance, low support requirements) and manufacturability. Emphasis is also placed on the propulsion system design, using an advanced ducted engine for low noise and improved propulsive efficiency. Author

**N95-26954# Wichita State Univ., Wichita, KS. Dept. of Aerospace
Engineering.**

FULL SPAN FLAPERONS FOR A BIPLANE

BONNIE L. JOHNSON *In* its AIAA Techfest 20 Proceedings 16 p 1994

Avail: CASI HC A03/MF A03

The work on this project produced the following conclusions: (1) full span flaperons involved the use of stabilator power for maneuvering flight not trim and reduced the pilot workload in approach to landing phase; (2) aerodynamically balanced ailerons work for flap deflections up to 12 deg, reduce the hinge moments for actuator design and produce roll authority up to flaps 12; and (3) full span flaps are a poor man's variable camber wing for maneuvering flight. CASI

**N95-26956*# National Aeronautics and Space Administration.
Langley Research Center, Hampton, VA.**

**INCORPORATING BIPLANE WING THEORY INTO A LARGE,
SUBSONIC, ALL-CARGO TRANSPORT**

MICHAEL K. ZYSKOWSKI *In* Wichita State Univ., AIAA Techfest 20 Proceedings p 1-15 1994

Avail: CASI HC A03/MF A03

If the air-cargo market increases at the pace predicted, a new conceptual aircraft will be demanded to meet the needs of the air-cargo industry. Furthermore, it has been found that not only should this aircraft be optimized to carry the intermodal containers used by the current shipping industry, but it should also be able to operate at existing airports. The best solution to these problems is a configuration incorporating a bi-wing planform, which has resulted in significant improvements over the monoplane in lift/drag, weight reduction, and span reduction. The future of the air-cargo market, biplane theory, wind tunnel tests, and a comparison of the aerodynamic characteristics of the biplane and monoplane are discussed. The factors pertaining to a biplane cargo transport are then examined, resulting in biplane geometric parameters. Author

**N95-26993 Army Aeromedical Research Lab., Fort Rucker, AL.
THE EFFECTS OF UH-1 EXPERIENCE ON UH-60
SIMULATOR PERFORMANCE: A PRELIMINARY STUDY
Final Report**

CHARLES A. SALTER, JOHN A. CALDWELL, JR., JOHN S. CROWLEY, and RONALD L. SMITH Nov. 1994 35 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): DA PROJ. 3M1-62787-A-879)

(AD-A289457; USAARL-95-4) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Efforts to expand the pool of volunteers for research in the UH-60 simulator prompted USAARL to determine whether UH-1 pilots could be used as an alternative to UH-60 subjects. In this quasi-experimental preliminary study, eight UH-1 pilots were provided with training in the UH-60 simulator. Afterwards, they were required to fly a standardized profile, parts of which had been used in an earlier investigation with UH-60 pilots. The performance accuracy of the

groups (UH-1 versus UH-60) were compared on equivalent maneuvers. Results showed that the UH-1 pilots used in this initial study actually performed better on most maneuvers than did the UH-60 pilots who were used in an earlier investigation. Thus, it appears that UH-1 pilots, who are easier to recruit than rated UH-60 pilots, may be suitable as subjects in future simulator studies involving basic instrument pilotage skills. However, before drawing definitive conclusions, these results should be replicated in a controlled study where the pilots are randomly assigned to training and testing conditions during a more limited time frame. DTIC

**N95-26994 Army Aviation Technical Test Center, Fort Rucker, AL.
TEST OPERATIONS PROCEDURE (TOP) 7-3-534**

**AIRWORTHINESS TESTING OF FIXED WING AIRCRAFT:
ASYMMETRIC POWER TESTING**

23 Dec. 1994 17 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(AD-A289458; TOP-7-3-534) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This TOP establishes procedures and methods for evaluating the asymmetric power handling qualities of multi-engine fixed-wing aircraft during developmental testing. This TOP is limited to handling qualities only and does not address aircraft performance. DTIC

N95-27018 AEPCO, Inc., Rockville, MD.

AH-1F COBRA REWIRE PROGRAM MANPRINT ANALYSIS

ROBERT A. CLARKE and WILLIAM J. BOLTRALIK 31 Aug. 1994 12 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): DABT60-90-D-0010)

(AD-A289190) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The purpose of this analysis was to review and analyze the AH-1F Cobra Rewire Program from a MANPRINT perspective. This was accomplished through examination of the AH-1F Cobra Rewire Program documentation and its technical publication, the Cobra Helicopter Rewire Manual (CHRM). Review of this program's documentation was conducted to identify MANPRINT deficiencies and develop corrective recommendations that ensure the CHRM would mitigate these shortcomings. The scope of this effort was primarily confined to the AH-1F Cobra Rewire Programs CHRM. Inputs to the CHRM were received from the AH-1 Cobra Project Management office (PMO), Army aviation maintenance facilities, fielded AH-1F Cobra units, and Korean Air Lines (KAL). Government furnished information (GFI) and contractor furnished information (CFI) from KAL were received in a fairly timely manner. Total integration of all AH-1F Cobra Rewire Program acquisitions efforts was beyond the scope of the delivery order. DTIC

**N95-27042 Air Force Inst. of Tech., Wright-Patterson AFB, OH.
School of Engineering.**

**IMPLEMENTATION AND DEMONSTRATION OF A MULTIPLE
MODEL ADAPTIVE ESTIMATION FAILURE DETECTION
SYSTEM FOR THE F-16 M.S. Thesis**

PETER K. EIDE Dec. 1994 215 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289301; AFIT/GE/ENG/94D-06) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

A Multiple Model Adaptive Estimation (MMAE) algorithm is implemented with the fully nonlinear six-degree-of-motion, Simulation Rapid-Prototyping Facility (SRF) VISTA F-16 software simulation tool. The algorithm is demonstrated to be capable of identifying flight critical aircraft actuator and sensor failures at a low dynamic pressure (20,000 ft, .4 Mach). Research included single and dual complete failures. Tuning methods for accommodating model mismatch, including addition of discrete dynamics pseudonoise and continuous measurement pseudonoise, are discussed and demonstrated. Scalar residuals within each filter are also examined and characterized for possible use as an additional failure declaration voter. Robustness to sensor failures provided by MMAE-based control is also demonstrated. An investigation of algorithm performance off the nominal

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

design conditions is accomplished as a first step towards full flight envelope coverage. The algorithm is composed of a bank of Kalman filters modeled to match particular hypotheses of the real world. Each presumes a single failure in one of the flight critical actuators (left/right stabilizers, left/right flaperon, rudder), or sensors (forward velocity, angle of attack, pitch rate, normal acceleration, roll rate, yaw rate, and lateral acceleration), and one presumes no failure. For dual failures, a hierarchical structure is used to keep the number of on-line filters to a minimum. This research advances the technology by testing algorithm performance against the most complete simulation model currently available. DTIC

N95-27143*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THE LIFT-FAN AIRCRAFT: LESSONS LEARNED

WALLACE H. DECKERT Mar. 1995 64 p

(Contract(s)/Grant(s): NAS2-5364)

(NASA-CR-196694; A-95041; NAS 1.26:196694) Avail: CASI HC A04/MF A01

This report summarizes the highlights and results of a workshop held at NASA Ames Research Center in October 1992. The objective of the workshop was a thorough review of the lessons learned from past research on lift fans, and lift-fan aircraft, models, designs, and components. The scope included conceptual design studies, wind tunnel investigations, propulsion systems components, piloted simulation, flight of aircraft such as the SV-5A and SV-5B and a recent lift-fan aircraft development project. The report includes a brief summary of five technical presentations that addressed the subject The Lift-Fan Aircraft: Lessons Learned.

Author

N95-27180*# Texas A&M Univ., College Station, TX.

SAILPLANE GLIDE PERFORMANCE AND CONTROL USING FIXED AND ARTICULATING WINGLETS M.S. Thesis

JAMES DAVID COLLING May 1995 100 p

(Contract(s)/Grant(s): NAG1-1522)

(NASA-CR-198579; NAS 1.26:198579) Avail: CASI HC A05/MF A02

An experimental study was conducted to investigate the effects of controllable articulating winglets on glide performance and yawing moments of high performance sailplanes. Testing was conducted in the Texas A&M University 7 x 10 foot Low Speed Wind Tunnel using a full-scale model of the outboard 5.6 feet of a 15 meter class high performance sailplane wing. Different wing tip configurations could be easily mounted to the wing model. A winglet was designed in which the cant and toe angles as well as a rudder on the winglet could be adjusted to a range of positions. Cant angles used in the investigation consisted of 5, 25, and 40 degrees measured from the vertical axis. Toe-out angles ranged from 0 to 22.5 degrees. A rudder on the winglet was used to study the effects of changing the camber of the winglet airfoil on wing performance and wing yawing moments. Rudder deflections consisted of -10, 0, and 10 degrees. Test results for a fixed geometry winglet and a standard wing tip are presented to show the general behavior of winglets on sailplane wings, and the effects of boundary-layer turbulators on the winglets are also presented. By tripping the laminar boundary-layer to turbulent before laminar separation occurs, the wing performance was increased at low Reynolds numbers. The effects on the lift and drag, yawing moment, pitching moment, and wing root bending moment of the model are presented. Oil flows were used on the wing model with the fixed geometry winglet and the standard wing tip to visualize flow directions and areas of boundary layer transition. A cant angle of 25 degrees and a toe-out angle of 2.5 degrees provided an optimal increase in wing performance for the cant and toe angles tested. Maximum performance was obtained when the winglet rudder remained in the neutral position of zero degrees. By varying the cant, toe, and rudder angles from their optimized positions, wing performance decreases. Although the winglet rudder proved to be more effective in increasing the yawing moment compared to varying the cant and toe angles, the amount of increased yawing moment was insignificant when compared to that produced by the vertical tail. A

rudder on the winglet was determined to be ineffective for providing additional yaw control.

Author

N95-27371*# Lockheed Engineering and Sciences Co., Hampton, VA.

A VERIFICATION PROCEDURE FOR MSC/NASTRAN FINITE ELEMENT MODELS

ALAN E. STOCKWELL Jun. 1995 24 p

(Contract(s)/Grant(s): NAS1-19000; RTOP 233-01-01-03)

(NASA-CR-4675; NAS 1.26:4675) Avail: CASI HC A03/MF A01

Finite Element Models (FEM's) are used in the design and analysis of aircraft to mathematically describe the airframe structure for such diverse tasks as flutter analysis and actively controlled landing gear design. FEM's are used to model the entire airplane as well as airframe components. The purpose of this document is to describe recommended methods for verifying the quality of the FEM's and to specify a step-by-step procedure for implementing the methods.

Author

N95-27440# Geophex Ltd., Raleigh, NC.

GEOPHEX AIRBORNE UNMANNED SURVEY SYSTEM

I. J. WON and D. W. A. TAYLOR 1995 13 p Presented at the Opportunity 95: Environmental Technology Through Small Business, Morgantown, WV, 16-17 Nov. 1994

(Contract(s)/Grant(s): DE-AR21-93MC-30358)

(DE95-007566; DOE/MC-30358/95/C0432; CONF-9411149-4) Avail: CASI HC A03/MF A01

The purpose of this effort is to design, construct, and evaluate a portable, remotely-piloted, airborne, geophysical survey system. This nonintrusive system will provide 'stand-off' capability to conduct surveys and detect buried objects, structures, and conditions of interest at hazardous locations. This system permits two operators to rapidly conduct geophysical characterization of hazardous environmental sites. During a survey, the operators remain remote from, but within visual distance, of, the site. The sensor system never contacts the Earth, but can be positioned near the ground so that weak anomalies can be detected.

DOE

N95-27504# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.

COMPOSITE REPAIR OF MILITARY AIRCRAFT STRUCTURES [LA REPARATION COMPOSITE DES STRUCTURES D'AVIONS MILITAIRES]

Jan. 1995 290 p In ENGLISH and FRENCH The 79th meeting was held in Seville, Spain, 3-5 Oct. 1994 Original contains color illustrations

(AGARD-CP-550; ISBN-92-836-0010-X) Copyright Avail: CASI HC A13/MF A03

The AGARD Structures and Materials Panel held a specialists' Meeting to address composite repair of military aircraft. The meeting focused on two main areas, repair of metal structures using composite patches and repair of composite structures using composite or metal patches. The work presented had direct application to the maintenance and support of military aircraft. Repair of military aircraft provides both a means to extend the useful life of the airframe beyond the original design life and a method to maintain military readiness by returning damaged aircraft to service. For individual titles, see N95-27505 through N95-27528.

N95-27505# Defence Science and Technology Organisation, Melbourne (Australia). Aeronautical and Maritime Research Lab. **BONDED COMPOSITE REPAIR OF METALLIC AIRCRAFT COMPONENTS: OVERVIEW OF AUSTRALIAN ACTIVITIES** A. A. BAKER In AGARD, Composite Repair of Military Aircraft Structures 14 p Jan. 1995

Copyright Avail: CASI HC A03/MF A03

After first providing an overview of the status of Australian applications of bonded composite repairs to metallic aircraft structure (mainly based on boron/epoxy composites) the problems in certifying composite repairs to critical cracks in primary metallic structure are discussed. The development of acceptable generic

certification procedures is essential if the use of this efficient cost-effective repair technology is to be widely employed in military and civil aircraft. One requirement for certification is the ability to predict the fatigue-crack growth behavior in patched components. An approach to developing this capability is described, based on Rose's model to estimate stress intensity in patched panels. The model is extended to allow for disbonding damage in the patch system. Experimental results are presented to demonstrate the validity of this approach for boron/epoxy-FM73 repairs to aluminum alloy 2024T3. Author

N95-27506# Textron Specialty Materials, Lowell, MA.
STATUS OF BONDED BORON/EPOXY DOUBLERS FOR MILITARY AND COMMERCIAL AIRCRAFT STRUCTURES
 E. B. BELASON *In* AGARD, Composite Repair of Military Aircraft Structures 12 p Jan. 1995
 Copyright Avail: CASI HC A03/MF A03

Bonded boron/epoxy doublers are an alternative method vs. riveted doublers for repair and reinforcement of metallic aircraft structures. The boron/epoxy doublers provide cost and/or performance advantages for many applications. Today over 4,500 are flying on military aircraft, mostly in Australia and the U.S.A., and the use is increasing. Commercial aircraft, which are also aging, are beginning to use this technology, with about 50 boron doublers flying for flight evaluation since 1989 (plus about another 100 since the mid 1970s in France). This paper summarizes the major uses of boron/epoxy doublers, focusing on recent and current U.S. applications (other papers at this Meeting describe activities in Australia, Canada, and France). These include a 1993 report summarizing the successful use on the wing pivot of over 400 F-111s for 20 years (no disbonds have been noted); fleetwide installations on the B-1 and C-141 (over 1800 doublers); and flight testing on F-16, T-38, C-130 and KC-135 aircraft. Commercially there have been successful flight evaluations on 2 Fed Ex 747s and the Lycoming ALF 502 engine cowl on 2 BAE 146s. A Service Bulletin has been issued for retrofit of over 1200 cowls for the latter. This paper also summarizes the installation process (which is very viable), and describes two recent technical advances in chemically preparing aluminum surfaces for bonding of boron/epoxy doublers. This paper also presents the results of an extensive test program sponsored by Textron at Boeing of 110 ultimate tensile strength and 143 fatigue tests of boron/epoxy doublers bonded to 7075-T6 aluminum with simulated cracks.

Author

N95-27507# Defence Research Agency, Farnborough, Hampshire (England). Structural Materials Centre.
ADHESIVELY BONDED COMPOSITE PATCH REPAIR OF CRACKED ALUMINUM ALLOY STRUCTURES
 P. POOLE, A. YOUNG, and A. S. BALL (British Aerospace Defence Ltd., Farnborough, England.) *In* AGARD, Composite Repair of Military Aircraft Structures 12 p Jan. 1995
 Copyright Avail: CASI HC A03/MF A03

Research at the Defence Research Agency (DRA) on adhesively bonded composite patch repair of fatigue cracked aluminum alloy structures is reviewed briefly. Theoretical and experimental results are reported which indicate the effectiveness of such repairs in terms of the reductions in stress intensity factor due to patching. The influence of warm-moist environments on the long-term performance of bonded patches is considered, and the advantages and disadvantages of using carbon fiber reinforced plastic (CFRP) patches, rather than boron fiber reinforced plastic (BFRP) patches, are discussed. An investigation by British Aerospace of the feasibility of using bonded composite patches to repair cracked primary aircraft structures is summarized. For the range of applications investigated, bonded composite patch repairs are shown to offer potential savings of 60-75 percent, compared to conventional repair methods. The current position regarding in-service trials is summarized, with no evidence of crack growth after 990 flying hours. Author

N95-27508# Dassault Aviation, Saint-Cloud (France).
COMPOSITE REPAIR OF METALLIC AIRFRAME: TWENTY

YEARS OF EXPERIENCE [REPARATIONS COMPOSITES DE STRUCTURES METALLIQUES: VINGT ANS D'EXPERIENCE]
 MICHELINE DRUET *In* AGARD, Composite Repair of Military Aircraft Structures 8 p Jan. 1995 *In* FRENCH
 Copyright Avail: CASI HC A02/MF A03

During the 70's, the availability of unidirectional boron fiber fabric at Dassault Aviation did allow reinforcement of metallic structures by direct ply lay up on the metal. To be able to apply these reinforcement on airplanes, it was necessary to define a resin system inducing low thermal stresses in the metal during its cure, and with acceptable mechanical properties after aging. Validation was done by simple tests on samples, by complex test with simultaneous thermal and mechanical cycling, and application of test repairs on the major fatigue test of the Mercure airplane. Reinforcements of that type are in service for almost 20 years on the Mercure airliner. Author

N95-27509# National Research Council of Canada, Ottawa (Ontario). Structures, Materials and Propulsion Lab.
BONDED COMPOSITE REPAIR OF THIN METALLIC MATERIALS: VARIABLE LOAD AMPLITUDE AND TEMPERATURE CYCLING EFFECTS
 M. D. RAIZENNE, T. J. BENAK, J. B. R. HEATH, D. L. SIMPSON, and A. A. BAKER (Defence Science and Technology Organisation, Melbourne, Australia.) *In* AGARD, Composite Repair of Military Aircraft Structures 12 p Jan. 1995 Original contains color illustrations
 Copyright Avail: CASI HC A03/MF A03

An investigation into the effectiveness of bonded boron/epoxy composite patch repairs on edge notched Al 2024-T3 sheets has been completed. Testing was carried out under variable amplitude load and temperature cycling. Nine sandwich type specimens were precracked of which eight were repaired using bonded precured unidirectional boron fiber reinforced epoxy patches. Three structural adhesive systems were evaluated, two thermally activated epoxies, FM73 and FM300, and a room temperature cure acrylic, Versilok 201. The variable amplitude load sequence used was FALSTAFF, a typical fighter aircraft loading spectrum. The temperature profile was derived from F/A-18 usage data. Temperatures varied between -35 C and +80 C with a one in eight temperature cycle occurrence of +108 C. The effect of moisture absorption in the adhesive and the matrix was also investigated. Bonded patches on three specimens were preconditioned to a moisture weight gain of 1.5 percent prior to testing. The data generated compares specimen fatigue crack growth rates between the three adhesives for three environments: room temperature, temperature cycled and temperature cycled with moisture preconditioning. Author

N95-27510# Bombardier, Inc., Montreal (Quebec). Defence Systems Div.
DESIGN AND STRUCTURAL VALIDATION OF CF116 UPPER WING SKIN BORON DOUBLER
 J. SMITH *In* AGARD, Composite Repair of Military Aircraft Structures 11 p Jan. 1995
 Copyright Avail: CASI HC A03/MF A03

Cracks were found around fastener holes in the critical area known as the 'Golden Triangle' on the upper wing skin of several CF116 aircraft. To restore the structural integrity of the wing, cracks around these fastener holes are removed and interference fit steel bushings are installed. A boron-epoxy doubler is then bonded over the reworked area to reduce stress levels. The doubler is viewed as a fatigue enhancement device and not as a repair to a cracked skin. An analytical methodology is used to assess the bond line integrity and the load transfer in the doubler. A 49% reduction of stress level is predicted by the bonded joint analytical approach. A finite element analysis reveals that a 47% stress reduction is expected in the exterior surface of the wing skin, while a 37% reduction in the interior surface is predicted. Based on a strain survey performed following the installation of a doubler on the CF116 full scale fatigue test, it is shown that analytical predictions agree with experimental results. Author

N95-27511# Georgia Inst. of Tech., Atlanta, GA. Computational Modeling Center.

A FEAM BASED METHODOLOGY FOR ANALYZING COMPOSITE PATCH REPAIRS OF METALLIC STRUCTURES

D. S. PIPKINS and S. N. ATLURI *In* AGARD, Composite Repair of Military Aircraft Structures 16 p Jan. 1995

Copyright Avail: CASI HC A03/MF A03

A Finite Element Alternating Method based methodology applicable to the analysis of composite patch repairs of metallic structures is presented. The method is completely general and may be used to efficiently analyze factors affecting repair design such as: global stiffening of the aircraft structure due to the high stiffness of the composite patch; the effect of size, shape, thickness and material properties of the composite patch on the crack-tip stress intensity factors; the effect of the material properties of the adhesive on the crack-tip stress intensity factors; the effect of thermal cycling on the composite repair; and the effect of disbands on the effectiveness of the composite repair. Author

N95-27512# Lockheed Aeronautical Systems Co., Marietta, GA. STRUCTURAL MODIFICATION AND REPAIR OF C-130 WING STRUCTURE USING BONDED COMPOSITES

J. GROSKO *In* AGARD, Composite Repair of Military Aircraft Structures 9 p Jan. 1995

Copyright Avail: CASI HC A02/MF A03

Lockheed Aeronautical Systems Company (LASC) — in a program sponsored by the United States Air Force, Warner Robins Air Logistics Center, C-130 Directorate — has developed concepts wherein bonded high-modulus composite materials can be applied to structurally repair or enhance the wing box of C-130 aircraft. Two separate approaches are taken. In the first, boron/epoxy reinforcing strips are applied to wing box lower surface structure to relieve high stress at a particular location in the wing surface panel. This modification is ideally used on undamaged structure to prevent wing surface cracking. In the second approach, graphite reinforced patches are applied in the same vicinity to arrest crack growth. Both concepts were successfully demonstrated on opposite sides of a full-scale wing test article. Design details, the materials and processes, the methods of installation and the measured effectiveness of both the boron/epoxy strips and the graphite/epoxy patches are discussed. Author (revised)

N95-27513# Lehigh Univ., Bethlehem, PA. Inst. of Fracture and Solid Mechanics.

EVALUATION OF PATCH EFFECTIVENESS IN REPAIRING AIRCRAFT COMPONENTS

G. C. SIH and E. E. GDOUTOS (Thrace Univ., Xanthi, Greece.) *In* AGARD, Composite Repair of Military Aircraft Structures 8 p Jan. 1995

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Reinforcement of aircraft components by patching is never completely effective because of improper bonding or damage of the reinforcement in service. There is always the uncertainty for evaluating the remaining strength or life of a repaired structure. Developed in this work is a methodology for evaluating the reinforcement effectiveness by considering two basic types of partially damaged patches; they are referred to as collinear and transverse debonding with respect to the crack plane. The former refers to debonding over a region ahead of only one of the crack tips where the load and geometry are symmetric across the crack plane, while the latter is concerned with debonding over a region to the side of the crack where symmetry is no longer preserved across the crack plane. Finite elements are employed to obtain the stresses and strains from which the strain energy densities can be determined for analyzing the failure behavior of the patched panels. The local and global maximum of the minimum strain energy density function, designated by $((dW/dV)_{sup max, sub min})_{sub L}$ at L and $((dW/dV)_{sup max, sub min})_{sub G}$ at G, are found and applied to define failure instability. The distance ell between L and G serves as a measure of crack instability; it increases with the debonded area. That is, debonding tends to enhance failure instability by fracture initiating from the existing crack. For approximately the same area of debonding,

crack initiation for collinear debonding would be more unstable as compared with transverse debonding for loads directed normal to the crack. Introduced also is a Patch Effectiveness Index (PEI) that serves as a measure of the load carrying capacity of the damaged patch. In this case, transverse debonding is more detrimental than collinear debonding because a more significant reduction in the load transfer path occurs in the former case. In general, both ell and PEI would have to be considered for assessing the integrity of the damaged patch. Author

N95-27514# Naval Air Warfare Center, Warminster, PA. Aircraft Div.

FIELD REPAIR MATERIALS FOR NAVAL AIRCRAFT

R. COCHRAN, R. TRABOCCO, P. MEHRKAM, and M. DIBERARDINO *In* AGARD, Composite Repair of Military Aircraft Structures 7 p Jan. 1995

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The Navy is unique in that a portion of the maintenance actions performed on operational aircraft must be accomplished on board ship or in remote field locations. Historically, Navy driven composite repair programs have addressed materials and concepts specifically directed at accomplishing repairs in the fleet operating environment. This paper discusses recent developments in the area of composite repair materials for the application of bonded patches to honeycomb and complex shaped monolithic composite structure. A two part adhesive that meets the storage and processing requirements for field repair applications was evaluated for use in repair of honeycomb structure. Low temperature adhesive processing and honeycomb compatibility tests were investigated. In another effort, wet lay-up repair resins and processes were characterized for repair of highly curved composite structure. The materials and equipment used in the study are fully compatible with field repair requirements. Composite repair materials for application of bonded patches to honeycomb and complex shaped monolithic composite structure are described. Low temperature adhesive processing development for bonding composite patches to moisturized structure is described. Cure temperatures as low as 90 C were used for curing a two part ambient storable adhesive. Mechanical properties and thermal stability of the cured adhesive is reported using a number of cycles. In another effort wet lay-up repair resins and processes were characterized which allow for the fabrication of fully inspectable wet lay-up patches. The materials and equipment are fully compatible with field repair requirements. Laminate mechanical properties and resin storage stability were characterized and reported. Author

N95-27515# Deutsche Aerospace A.G., Munich (Germany). Military Aircraft Div.

ON AIRCRAFT REPAIR VERIFICATION OF A FIGHTER A/C INTEGRALLY STIFFENED FUSELAGE SKIN

J. BAUER and A. MAIER *In* AGARD, Composite Repair of Military Aircraft Structures 14 p Jan. 1995

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A considerably large four point bending test box was available simulating the curved integrally stiffened CFC fuselage skin of a fighter aircraft. This box was used for a skin repair trial with subsequent testing. The repair was performed in the environment of an external test laboratory, i.e. abroad of the original shop or maintenance facilities. 'On Aircraft' conditions have been simulated with all the referring access, tooling and quality assurance difficulties. The repaired test box demonstrated during static testing, loading the repair in tension, compression and shear, that the applied repair procedure is feasible to be applied on CFC structures. The repair procedure and the subsequent testing will be presented and the results will be discussed. Author

N95-27516# Lockheed-Fort Worth Co., Fort Worth, TX.

RAPID REPAIR OF LARGE AREA DAMAGE TO CONTOURED AIRCRAFT STRUCTURES

JAMES A. FRAILEY and DOUGLAS W. CARTER (Wright Lab., Wright-Patterson AFB, OH.) *In* AGARD, Composite Repair of Military Aircraft Structures 9 p Jan. 1995

Copyright Avail: CASI HC A02/MF A03

In a program sponsored by Air Force Wright Laboratory (WL/FIVST), Lockheed Fort Worth Company has developed field-level procedures for repair of large area damage to highly contoured aircraft structures. The combination of aircraft structures designed with enhanced survivability and the utilization of larger and more powerful ballistic threats have resulted in the requirement to develop new, creative approaches for rapid repair of large area structural damage. Furthermore, current aircraft design employing advanced composite materials on highly contoured surfaces increases the challenge of implementing workable battle damage repairs. This paper details the development of an advanced battle damage repair concept designed to repair damage up to approximately 15 inches in diameter on highly contoured surfaces. It employs a quick, reusable tooling mold that replicates the contour of the damaged aircraft for the purpose of processing a composite patch. Several one year room temperature storable, thermoset, composite systems were examined for processability, handleability and mechanical performance to determine their suitability as repair patch materials. The most promising were further tested and demonstrated in a large scale validation test. Author

N95-27517# Deutsche Aerospace A.G., Munich (Germany). Military Aircraft Div.

COMPOSITE REPAIR OF A CF18: VERTICAL STABILIZER LEADING EDGE

A. E. MAIER and G. GUENTHER *In* AGARD, Composite Repair of Military Aircraft Structures 16 p Jan. 1995
Copyright Avail: CASI HC A03/MF A03

This paper describes the engineering and manufacturing procedures that were applied in a repair task of a CF18 Vertical Stabilizer Leading Edge, made out of CFC honeycomb structure with multiple in-service impact damages in an aerodynamic sensitive area of the fin. 'On-aircraft' damage assessment, manufacturing of a relatively thin contoured CFC doubler, replacement of metal honeycomb core and finally quality assurance and strength verification procedures of the repair are described to restore full design strength of the component and the operational aircraft capability. Author

N95-27518# Defence Research Establishment Pacific, Victoria (British Columbia).

COMPOSITE REPAIR ISSUES ON THE CF-18 AIRCRAFT

A. J. RUSSELL and J. S. FERGUSON *In* AGARD, Composite Repair of Military Aircraft Structures 8 p Jan. 1995
Copyright Avail: CASI HC A02/MF A03

This paper addresses three separate composite repair issues currently being investigated at the Defence Research Establishment Pacific (DREP) in support of Canada's CF-18 aircraft. First, the problem of skin/core debonding that can occur during elevated temperature bonded repairs of honeycomb sandwich structure is discussed and the results of tests which help to quantify the role played by bondline degradation are presented. Next, the final development phase of an ongoing effort to establish a reliable and effective means of repairing delamination damage is reported. In particular, the design of a resin injection device and a series of tests to evaluate its performance are described. Finally, a battle damage repair issue, namely the advantages and disadvantages of cleaning up the damaged composite material found around entry and exit holes created by live fire, is discussed. Test data is presented which compares the different consequences under tensile and compression loading. Author

N95-27519# Northrop Grumman Corp., Hawthorne, CA. Aircraft Div.

REPAIR TECHNOLOGY FOR THERMOPLASTIC AIRCRAFT STRUCTURES

M. W. HEIMERDINGER et al. *In* AGARD, Composite Repair of Military Aircraft Structures 12 p Jan. 1995
Copyright Avail: CASI HC A03/MF A03

The Flight Dynamics and Materials Directorates of the U.S. Air Force Wright Aeronautical Laboratories jointly sponsored a program for 'Repair Technology for Thermoplastic Aircraft Structures'

(REPTAS) performed by Northrop Corporation, Aircraft Division. In the program Northrop developed, validated and demonstrated on-aircraft repair design concepts and processes for field repair of advanced thermoplastic structures. The REPTAS program was accomplished through the performance of a 48-month effort comprising three phases. Phase 1 assessed field level repair facilities and technology that are currently available and identified their applicability to repair thermoplastic (TP) structures. A baseline aircraft structure was selected to validate the selected repair process. Currently available thermoplastic materials were reviewed and materials selected for evaluation. In the selection process the objective was to select one semicrystalline, one amorphous, and one pseudo-thermoplastic material. APC-2 was evaluated as the baseline material for the process development efforts. Novel processing techniques were investigated for the repair procedures. Phase 2 developed the selected technologies for the on-aircraft repair of TP structures at a coupon and subelement level. Design concepts were developed that are compatible with field level capabilities and restore structural integrity to the aircraft. In the process of developing a bonding procedure using polyetheretherketone (PEEK) as the bonding film, it became apparent that the required bonding temperature of 385 C (725 F) created internal thermal stresses in the base structure and resulted in unacceptable delaminations. As an alternative, an investigation of amorphous bonding was included which demonstrated its feasibility for TP repair. In Phase 3 a full-scale advanced thermoplastic composite structural component was selected and used as a demonstration article for the selected design concept. Derived from text

N95-27520# Vought Corp., Dallas, TX. Aircraft Div.

REPAIR OF HIGH TEMPERATURE COMPOSITE AIRCRAFT STRUCTURE

JEROME J. CONNOLLY *In* AGARD, Composite Repair of Military Aircraft Structures 12 p Jan. 1995
Copyright Avail: CASI HC A03/MF A03

This paper describes the final portion of a high temperature composite repair development program sponsored by Wright Patterson Materials Directorate. Initially, BMI adhesives and prepreps were selected based on their compatibility with in-service repair cure scenarios. These typically involve curing in a non-autoclave environment using vacuum consolidation only. The selected material systems were then used to develop a comprehensive repair procedure for highly curved aircraft structure. Once developed, the procedure was then applied to a curved structure representative of a flight surface leading edge. Baseline and repair specimens were fabricated and tested in compression at both room temperature dry and elevated temperature dry conditions. The results of these test validated the repair procedure. Author

N95-27521# British Aerospace Defence Ltd., Preston (England). Military Aircraft Div.

COMPOSITE REPAIR OF COMPOSITE STRUCTURES

C. S. FRAME *In* AGARD, Composite Repair of Military Aircraft Structures 11 p Jan. 1995
Copyright Avail: CASI HC A03/MF A03

Composite repair results from previous Phases of the Ministry of Defence/British Aerospace funded 'Defect, Damage and Repair' (DDR) program are used to illustrate the ability to perform adequate strength repairs to composite structures using composite materials. Problems inhibiting the wider use of composite repairs are discussed and work in progress in the current Phase of the DDR program aimed at overcoming these problems, is presented. Author

N95-27522# Eurocopter Deutschland G.m.b.H., Munich (Germany).

EXTERNAL PATCH REPAIR OF CFRP/HONEYCOMB SANDWICH

K. WOLF and R. SCHINDLER *In* AGARD, Composite Repair of Military Aircraft Structures 11 p Jan. 1995
Copyright Avail: CASI HC A03/MF A03

This paper addresses the repair of impact-damaged honey-

comb sandwich structures with thin skins made of carbon fiber reinforced plastic (CFRP). An experimental study concerned with evaluating several types of bonded external patch repairs is presented. The evaluation included cocured as well as precured patch techniques utilizing advanced repair materials. Three repair schemes were applied to honeycomb sandwich manufactured from 125 C as well as 175 C curing carbon fiber reinforced fabric prepreps. The effectiveness of the repairs was examined through a series of static and fatigue compression tests. Based on the mechanical test results and a comparison of the repair procedures it was found that the bonded precured patch concept is the most suitable approach for repairing impact-damaged sandwich structures under field-level maintenance limitations. Author

N95-27523# Defence Science and Technology Organisation, Melbourne (Australia). Aeronautical and Maritime Research Lab. **SCARF REPAIRS TO GRAPHITE/EPOXY COMPONENTS** A. A. BAKER, R. J. CHESTER, G. R. HUGO, and T. C. RADTKE In AGARD, Composite Repair of Military Aircraft Structures 12 p Jan. 1995

Copyright Avail: CASI HC A03/MF A03

Significant damage to graphite/epoxy laminates up to 16 plies in thickness is often repaired with a bonded external patch. This type of repair is well suited to honeycomb panels and is relatively easy to apply even under field conditions. Thicker laminates generally carry too much load for external patch repairs and so either bolted patches or scarf repairs are generally used. Scarf repairs exhibit a nominally uniform shear stress distribution within the joint and have the advantage of low peel stress due to the lack of eccentricity in the load path. Scarf repairs are, however, difficult to produce, may involve the removal of a significant amount of parent material, and the uniform shear stresses may make the joint susceptible to creep failure. An experimental program was undertaken to determine the strain capacity of a scarf repair to a 21 ply laminate. The aim of the program is to demonstrate a strain capability in the repair of at least 5200 microstrain when tested under hot/wet conditions. Although some of the specimens tested have achieved this strain level, the performance of the current scarf joint is marginal under these conditions. Detailed analysis of this joint shows that high stresses arise from ply drop-offs within the repair doubler and at the ends of the scarf taper. Good correlation has been observed between the results from the Finite-Element models and those from experimental specimens, indicating that the models are a useful tool to assist in the design of joints of this type. Author

N95-27524# Turkish Land Forces Command, Ankara (Turkey). **SCARF JOINT TECHNIQUE WITH COCURED AND PRECURED PATCHES FOR COMPOSITE REPAIR**

F. ELALDI, S. LEE (Institute for Aerospace Research, Ottawa, Ontario.), and R. F. SCOTT (Institute for Aerospace Research, Ottawa, Ontario.) In AGARD, Composite Repair of Military Aircraft Structures 12 p Jan. 1995

Copyright Avail: CASI HC A03/MF A03

The scarf joint technique is one of the latest techniques used for repairing composite aircraft structures. This paper describes scarf joints comprised of vacuum and autoclave precured and cocured fiber glass epoxy patches bonded to autoclave and vacuum precured parent fiber glass epoxy laminates. Autoclave and vacuum cured parent laminates and the scarf joints were prepared and exposed to the same temperature and moisture environment for comparison. All specimens were loaded in tension at three temperatures. Interlaminar shear strength (ILSS) tests were also carried out for the parent materials. As expected, the tensile strength and ILSS decrease when the material has been exposed to moisture and tested at elevated temperature. No significant difference was reported for either tensile strength or ILSS between autoclave and vacuum cured materials. The room temperature repair efficiencies are reported for single scarf repairs comprised of vacuum cocured and precured patches. These repair efficiencies were found to be similar to the efficiency of the autoclave precured patch repair. This result supports the feasibility of scarf joint repairs in base level facilities. Author

N95-27525# Aerospatiale, Toulouse (France). Composite Structures Div.

COMPOSITE OR METALLIC BOLTED REPAIRS ON SELF-STIFFENED CARBON WING PANEL OF THE COMMUTER ATR72 DESIGN CRITERIA, ANALYSIS, VERIFICATION BY TEST

A. TROPIS In AGARD, Composite Repair of Military Aircraft Structures 21 p Jan. 1995

Copyright Avail: CASI HC A03/MF A03

The introduction into service, in 1989, of ATR72 with an outer wing in carbon led Aerospatiale to develop primary structure repair processes which fulfill Airworthiness requirements and which could be performed by the airlines in typical maintenance conditions. This paper describes the two types of bolted repairs developed within the scope of the wing certification: composite doubler or metallic doubler. An analytical microcomputer calculation program allows the critical area and the strength capability of the repaired panel to be determined. This program is validated by tests. Author

N95-27526# Deutsche Airbus G.m.b.H., Hamburg (Germany).

DAMAGE OCCURRENCE ON COMPOSITES DURING TESTING AND FLEET SERVICE: REPAIR OF AIRBUS AIRCRAFT

G. STEMMER In AGARD, Composite Repair of Military Aircraft Structures 8 p Jan. 1995

Copyright Avail: CASI HC A02/MF A03

The application of composite materials to civil aircraft structure was growing during the past 25 years with every new aircraft which went into service. With these materials in commercial use it became necessary to define repairs in the case the component becomes damaged. During fatigue testing at component level the limits for allowable damage and maximum repair sizes were determined for standard damage events and manufacturing defects. The values are depending on structural design, material behavior and local strains or stresses. For simple damages on regular structures necessary repair actions are defined in the Structural Repair Manual. With an approved inspection philosophy the structure is under observation during airline service. It will be presented how the repair philosophy within Airbus Industrie partner companies is defined and which damages were reported on aircraft already in service. Some examples should explain the lessons we have learned from those failures occurred during component testing and airline service. Author

N95-27527# Construcciones Aeronauticas S.A., Madrid (Spain). **REPAIRS OF CFC PRIMARY STRUCTURES**

H. GARCIANUNEZ, A. BARRIOCADABA, and A. FRANGANILLO In AGARD, Composite Repair of Military Aircraft Structures 10 p Jan. 1995

Copyright Avail: CASI HC A02/MF A03

The use of composites in the last decades has been mainly restricted to secondary structures, with repair methods well known to the airlines. In today's aircraft, a significant amount of primary structure is designed and built in high strength composite materials. Repairs for these elements must take into consideration the restoration of structural strength and stiffness, still being easy to be applied by aircraft operators, with a minimum of special facilities, and requiring a minimum of aircraft-on-ground time. A large number of important structural elements in CFC now in service have been designed and manufactured by CASA. This paper describes how composite repairs are dealt with at CASA, starting from the design board, and the analyses and tests carried out to demonstrate compliance with certification requirements. Author

N95-27528# Royal Australian Air Force, Amberley (Australia). Aero-Mechanical Technologies and Standards.

THE DEVELOPMENT OF AN ENGINEERING STANDARD FOR COMPOSITE REPAIRS

M. J. DAVIS In AGARD, Composite Repair of Military Aircraft Structures 11 p Jan. 1995

Copyright Avail: CASI HC A03/MF A03

The RAAF has used bonded composite patches for structural

repairs to aircraft for nearly twenty years, and they are now seen as a reliable alternative to mechanically fastened repairs. To control the implementation of the repair technology, RAAF propose to adopt Engineering Standard C5033 on Composite Materials and Adhesive Bonded Repairs. The Standard addresses repair authorization and design, as well as repair methodology and quality control. This paper will describe the philosophy of repair design contained in the standard, and outline the materials and process controls necessary for performance of repairs which comply with ISO 9001. Author

N95-27910# General Accounting Office, Washington, DC. National Security and International Affairs Div.
REPORT TO CONGRESSIONAL COMMITTEES. COMANCHE HELICOPTER: TESTING NEEDS TO BE COMPLETED PRIOR TO PRODUCTION DECISIONS

May 1995 30 p

(GAO/NSIAD-95-112; B-259389) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20884-6015 HC

Cost and technical issues associated with the Department of the Army's Comanche helicopter program are reported. CASI

N95-27918 Defence Science and Technology Organisation, Melbourne (Australia). Aeronautical and Maritime Research Lab.
A REVIEW OF AUSTRALIAN AND NEW ZEALAND INVESTIGATIONS ON AERONAUTICAL FATIGUE DURING THE PERIOD APR. 1993 - MAR. 1995

J. M. GRANDAGE and G. S. JOST Mar. 1995 34 p Presented at the 24th Conference of the International Committee on Aeronautical Fatigue, Melbourne, Australia, 1-2 May 1995 (AR-009-202; DSTO-TN-0002) Copyright Avail: Issuing Activity (Defence Science and Technology Organisation, Melbourne, Australia)

This document was prepared for presentation to the 24th Conference of the International Committee on Aeronautical Fatigue scheduled to be held in Melbourne, Australia on 1-2 May 1995. A review is given of the aircraft fatigue research and associated activities which form part of the programs of the Aeronautical and Maritime Research Laboratory, Universities, the Civil Aviation Authority and the Defence Scientific Establishment, New Zealand. The review summarizes fatigue-related research programs as well as fatigue investigations on specific military and civil aircraft. Author

N95-28262*# California Univ., Los Angeles, CA.
AEROELASTICITY AND STRUCTURAL OPTIMIZATION OF COMPOSITE HELICOPTER ROTOR BLADES WITH SWEEP TIPS

K. A. YUAN and P. P. FRIEDMANN Hampton, VA NASA May 1995 433 p

(Contract(s)/Grant(s): NAG1-833; RTOP 505-63-36-06)

(NASA-CR-4665; NAS 1.26:4665) Avail: CASI HC A19/MF A04

This report describes the development of an aeroelastic analysis capability for composite helicopter rotor blades with straight and swept tips, and its application to the simulation of helicopter vibration reduction through structural optimization. A new aeroelastic model is developed in this study which is suitable for composite rotor blades with swept tips in hover and in forward flight. The hingeless blade is modeled by beam type finite elements. A single finite element is used to model the swept tip. Arbitrary cross-sectional shape, generally anisotropic material behavior, transverse shears and out-of-plane warping are included in the blade model. The nonlinear equations of motion, derived using Hamilton's principle, are based on a moderate deflection theory. Composite blade cross-sectional properties are calculated by a separate linear, two-dimensional cross section analysis. The aerodynamic loads are obtained from quasi-steady, incompressible aerodynamics, based on an implicit formulation. The trim and steady state blade aeroelastic response are solved in a fully coupled manner. In forward flight, where the blade equations of motion are periodic, the coupled trim-aeroelastic response solution is obtained from the harmonic balance method. Subsequently, the periodic system is linearized about the steady state response, and its stability is determined from Floquet theory. Author

N95-28278*# Martin Marietta Corp., Baltimore, MD. Aero and Naval Systems.

APPLICATION OF FIBER-REINFORCED BISMALIMIDE MATERIALS TO AIRCRAFT NACELLE STRUCTURES

VASILIOS PEROS, JOHN RUTH, and DAVID TRAWINSKI In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 3 p 1333-1347 Sep. 1992

Copyright Avail: CASI HC A03/MF A04

Existing aircraft engine nacelle structures employ advanced composite materials to reduce weight and thereby increase overall performance. Use of advanced composite materials on existing aircraft nacelle structures includes fiber-reinforced epoxy structures and has typically been limited to regions furthest away from the hot engine core. Portions of the nacelle structure that are closer to the engine require materials with a higher temperature capability. In these portions, existing nacelle structures employ aluminum sandwich construction and skin/stringer construction. The aluminum structure is composed of many detail parts and assemblies and is usually protected by some form of ablative, insulator, or metallic thermal shield. A one-piece composite inner cowl for a new-generation engine nacelle structure has been designed using fiber-reinforced bismaleimide (BMI) materials and honeycomb core in a sandwich construction. The new composite design has many advantages over the existing aluminum structure. Multiple details were integrated into the one-piece composite design, thereby significantly reducing the number of detail parts and fasteners. The use of lightweight materials and the reduction of the number of joints result in a significant weight reduction over the aluminum design; manufacturing labor and the overall number of tools required have also been reduced. Several significant technical issues were addressed in the development of a BMI composite design. Technical evaluation of the available BMI systems led to the selection of a toughened BMI material which was resistant to microcracking under thermal cyclic loading and enhanced the damage tolerance of the structure. Technical evaluation of the degradation of BMI materials in contact with aluminum and other metals validated methods for isolation of the various materials. Graphite-reinforced BMI in contact with aluminum and some steels was found to degrade in salt spray testing. Isolation techniques such as those used for graphite-reinforced epoxy structures were shown to provide adequate protection. The springback and producibility of large BMI structures were evaluated by manufacturing prototype hardware which had the full-scale cross section of the one-piece composite structure. Author

N95-28409 Israel Inst. of Metals, Haifa (Israel).

PREDICTION OF FATIGUE CRACK GROWTH UNDER CONSTANT AMPLITUDE AND RANDOM LOADING USING SPECIMENS WITH MULTIPLE CRACKS Final Report, 1 Oct. 1993 - 30 Sep. 1994

SH. USTILOVSKY, R. ARONE, J. OSHRAT, E. STERIN, and G. NESVISZSKY Dec. 1994 78 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (Contract(s)/Grant(s): F49620-93-1-0579)

(AD-A291614; TR-524727; EOARD-TR-95-06) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Fatigue crack growth under stationary Gaussian random loading is considered. A specially developed computerized testing system and software are used for generation of the random loading and investigation of crack growth. The sliding summation numerical method was used for generation of a random loading history characterized by a given autocorrelation function. As far as the loading history of a sufficient length is generated a sequence of maxima and minima is extracted and arranged with the predetermined frequency. The next operation is elimination of the small amplitude cycles in accordance with the predetermined threshold value and determination of the minima and maxima two-dimensional distribution of the edited process. A specially built transition matrix derived from this distribution was used for the real-time generation of the random loading during the test. Experimental investigation of the developed random loading generation procedure and crack growth process was performed using aluminium alloy multicrack panel type speci-

mens providing possibility of observation of an array of simultaneously growing cracks. Dependence of fatigue crack life time on random loading parameters as well as stochastic characteristics of crack growth were studied. DTIC

N95-28411 Department of Defense, Washington, DC.
UNMANNED AERIAL VEHICLES, 1994 MASTER PLAN
1995 131 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A291628) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The Unmanned Aerial Vehicles (UAV) Joint Project Office was officially established in response to Congressional direction by a charter signed by the Director of Defense Research and Engineering on 16 October 1989. This 1994 UAV Master Plan is the sixth submission to Congress. It provides the acquisition and technology strategies, management, and program plans for nonlethal UAV's. Lethal UAV's are addressed in the classified Department of Defense Standoff Weapons Master Plan. This Master Plan is structured into three parts: an Executive Summary, a main body of 10 sections providing extensive detail, and an appendix of supporting material including discussions of dual uses of UAV's and UAV civil airspace management issues. DTIC

N95-28440* Wright Lab., Wright-Patterson AFB, OH. Flight Dynamics Directorate.
STRUCTURAL DESIGN OPTIMIZATION WITH SURVIVABILITY DEPENDENT CONSTRAINTS APPLICATION: PRIMARY WING BOX OF A MULTI-ROLE FIGHTER

DOUGLAS J. DOLVIN In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 465-487 Sep. 1992
Avail: CASI HC A03/MF A04

The superior survivability of a multirole fighter is dependent upon balanced integration of technologies for reduced vulnerability and susceptibility. The objective is to develop a methodology for structural design optimization with survivability dependent constraints. The design criteria for optimization will be survivability in a tactical laser environment. The following analyses are studied to establish a dependent design relationship between structural weight and survivability: (1) develop a physically linked global design model of survivability variables; and (2) apply conventional constraints to quantify survivability dependent design. It was not possible to develop an exact approach which would include all aspects of survivability dependent design, therefore guidelines are offered for solving similar problems. Derived from text

N95-28444* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PROBABILISTIC EVALUATION OF FUSELAGE-TYPE COMPOSITE STRUCTURES
MICHAEL C. SHIAO (Sverdrup Technology, Inc., Brook Park, OH.) and CHRISTOS C. CHAMIS In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 535-547 Sep. 1992 Previously announced as N93-12735
Avail: CASI HC A03/MF A04

A methodology is developed to computationally simulate the uncertain behavior of composite structures. The uncertain behavior includes buckling loads, natural frequencies, displacements, stress/strain etc., which are the consequences of the random variation (scatter) of the primitive (independent random) variables in the constituent, ply, laminate and structural levels. This methodology is implemented in the IPACS (Integrated Probabilistic Assessment of Composite Structures) computer code. A fuselage-type composite structure is analyzed to demonstrate the code's capability. The probability distribution functions of the buckling loads, natural frequency, displacement, strain and stress are computed. The sensitivity of each primitive (independent random) variable to a given structural response is also identified from the analyses. Derived from text

N95-28470* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TEST AND ANALYSIS RESULTS FOR COMPOSITE TRANSPORT FUSELAGE AND WING STRUCTURES
JERRY W. DEATON, SUSAN M. KULLERD (Lockheed Engineering and Sciences Co., Hampton, VA.), RAM C. MADAN (Douglas Aircraft Co., Inc., Long Beach, CA.), and VICTOR L. CHEN (Douglas Aircraft Co., Inc., Long Beach, CA.) In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 719-743 Sep. 1992 Previously announced as X92-10413
Avail: CASI HC A03/MF A04

Automated tow placement (ATP) and stitching of dry textile composite preforms followed by resin transfer molding (RTM) are being investigated by researchers at NASA LaRC and Douglas Aircraft Company as cost-effective manufacturing processes for obtaining damage tolerant fuselage and wing structures for transport aircraft. The Douglas work is being performed under a NASA contract entitled 'Innovative Composites Aircraft Primary Structures (ICAPS)'. Data are presented in this paper to assess the damage tolerance of ATP and RTM fuselage elements with stitched-on stiffeners from compression tests of impacted three-J-stiffened panels and from stiffener pull-off tests. Data are also presented to assess the damage tolerance of RTM wing elements which had stitched skin and stiffeners from impacted single stiffener and three blade-stiffened compression tests and stiffener pull-off tests. Author

N95-28471* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TENSION FRACTURE OF LAMINATES FOR TRANSPORT FUSELAGE. PART 1: MATERIAL SCREENING
T. H. WALKER (Boeing Commercial Airplane Co., Seattle, WA.), W. B. AVERY (Boeing Commercial Airplane Co., Seattle, WA.), L. B. ILCEWICZ (Boeing Commercial Airplane Co., Seattle, WA.), C. C. POE, JR., and C. E. HARRIS In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 747-787 Sep. 1992 Previously announced as X92-10414
(Contract(s)/Grant(s): NAS1-18889)
Avail: CASI HC A03/MF A04

Transport fuselage structures are designed to contain pressure following a large penetrating damage event. Applications of composites to fuselage structures require a database and supporting analysis on tension damage tolerance. Tests with 430 fracture specimens were used to accomplish the following: (1) identify critical material and laminate variables affecting notch sensitivity; (2) evaluate composite failure criteria; and (3) recommend a screening test method. Variables studied included fiber type, matrix toughness, lamination manufacturing process, and intraply hybridization. The laminates found to have the lowest notch sensitivity were manufactured using automated tow placement. This suggests a possible relationship between the stress distribution and repeatable levels of material inhomogeneity that are larger than found in traditional tape laminates. Laminates with the highest notch sensitivity consisted of toughened matrix materials that were resistant to a splitting phenomena that reduces stress concentrations in major load bearing plies. Parameters for conventional fracture criteria were found to increase with crack length for the smallest notch sizes studied. Most material and laminate combinations followed less than a square root singularity for the largest crack sizes studied. Specimen geometry, notch type, and notch size were evaluated in developing a screening test procedure. Traditional methods of correcting for specimen finite width were found to be lacking. Results indicate that a range of notch sizes must be tested to determine notch sensitivity. Data for a single small notch size (0.25 in. diameter) was found to give no indication of the sensitivity of a particular material and laminate layout to larger notch sizes. Author

N95-28473* Boeing Commercial Airplane Co., Seattle, WA.
LOCAL DESIGN OPTIMIZATION FOR COMPOSITE TRANSPORT FUSELAGE CROWN PANELS
G. D. SWANSON, L. B. ILCEWICZ, T. H. WALKER, D. GRAESSER (Washington Univ., Seattle, WA.), M. TUTTLE (Washington Univ.,

Seattle, WA.), and Z. ZABINSKY (Washington Univ., Seattle, WA.) *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 795-814 Sep. 1992 Previously announced as X92-10416
(Contract(s)/Grant(s): NAS1-18889)
Avail: CASI HC A03/MF A04

Composite transport fuselage crown panel design and manufacturing plans were optimized to have projected cost and weight savings of 18 percent and 45 percent, respectively. These savings are close to those quoted as overall NASA ACT program goals. Three local optimization tasks were found to influence the cost and weight of fuselage crown panels. This paper summarizes the effect of each task and describes in detail the task associated with a design cost model. Studies were performed to evaluate the relationship between manufacturing cost and design details. A design tool was developed to aid in these investigations. The development of the design tool included combining cost and performance constraints with a random search optimization algorithm. The resulting software was used in a series of optimization studies that evaluated the sensitivity of design variables, guidelines, criteria, and material selection on cost. The effect of blending adjacent design points in a full scale panel subjected to changing load distributions and local variations was shown to be important. Technical issues and directions for future work were identified. Author

**N95-28474*# Boeing Commercial Airplane Co., Seattle, WA.
COMPOSITE FUSELAGE CROWN PANEL
MANUFACTURING TECHNOLOGY**

KURTIS WILLDEN, S. METSCHAN, C. GRANT (Hercules Aerospace Co., Magna, UT.), and T. BROWN (Hercules Aerospace Co., Magna, UT.) *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 815-841 Sep. 1992 Previously announced as X92-10417
(Contract(s)/Grant(s): NAS1-18889)
Avail: CASI HC A03/MF A04

Commercial fuselage structures contain significant challenges in attempting to save manufacturing costs with advanced composite technology. Assembly issues, material costs, and fabrication of elements with complex geometry are each expected to drive the cost of composite fuselage structures. Boeing's efforts under the NASA ACT program have pursued key technologies for low-cost, large crown panel fabrication. An intricate bond panel design and manufacturing concepts were selected based on the efforts of the Design Build Team (DBT). The manufacturing processes selected for the intricate bond design include multiple large panel fabrication with the Advanced Tow Placement (ATP) process, innovative cure tooling concepts, resin transfer molding of long fuselage frames, and utilization of low-cost material forms. The process optimization for final design/manufacturing configuration included factory simulations and hardware demonstrations. These efforts and other optimization tasks were instrumental in reducing cost by 18 percent and weight by 45 percent relative to an aluminum baseline. The qualitative and quantitative results of the manufacturing demonstrations were used to assess manufacturing risks and technology readiness. Author

**N95-28476*# Lockheed Aeronautical Systems Co., Marietta, GA.
ADVANCED TEXTILE APPLICATIONS FOR PRIMARY
AIRCRAFT STRUCTURES**

ANTHONY C. JACKSON, RONALD E. BARRIE, BHARAT M. SHAH, and JAY G. SHUKLA *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 875-902 Sep. 1992 Previously announced as X92-10419
(Contract(s)/Grant(s): NAS1-18888)
Avail: CASI HC A03/MF A04

Advanced composite primary structural concepts have been evaluated for low cost, damage tolerant structures. Development of advanced textile preforms for fuselage structural applications with resin transfer molding and powder epoxy material is now under development. Author

N95-28480*# Dow-United Technologies Composite Products, Inc., Wallingford, CT.

**APPLICATION OF DAMAGE TOLERANCE METHODOLOGY
IN CERTIFICATION OF THE PIAGGIO P-180 AVANTI**

JERRY JOHNSON *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 999-1012 Sep. 1992
Avail: CASI HC A03/MF A04

The Piaggio P-180 Avanti, a twin pusher-prop engine nine-passenger business aircraft was certified in 1990, to the requirements of FAR Part 23 and Associated Special Conditions for Composite Structure. Certification included the application of a damage tolerant methodology to the design of the composite forward wing and empennage (vertical fin, horizontal stabilizer, tailcone, and rudder) structure. This methodology included an extensive analytical evaluation coupled with sub-component and full-scale testing of the structure. The work from the Damage Tolerance Analysis Assessment was incorporated into the full-scale testing. Damage representing hazards such as dropped tools, ground equipment, handling, and runway debris, was applied to the test articles. Additional substantiation included allowing manufacturing discrepancies to exist unrepaired on the full-scale articles and simulated bondline failures in critical elements. The importance of full-scale testing in the critical environmental conditions and the application of critical damage are addressed. The implication of damage tolerance on static and fatigue testing is discussed. Good correlation between finite element solutions and experimental test data was observed. Author

**N95-28482*# Boeing Commercial Airplane Co., Seattle, WA.
IMPACT DAMAGE RESISTANCE OF COMPOSITE
FUSELAGE STRUCTURE, PART 1**

E. F. DOST, W. B. AVERY, L. B. ILCEWICZ, D. H. GRANDE, and B. R. COXON (Integrated Technologies, Inc., Bothell, WA.) *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 1037-1069 Sep. 1992
(Contract(s)/Grant(s): NAS1-18889)
Avail: CASI HC A03/MF A04

The impact damage resistance of laminated composite transport aircraft fuselage structures was studied experimentally. A statistically based designed experiment was used to examine numerous material, laminate, structural, and extrinsic (e.g., impactor type) variables. The relative importance and quantitative measure of the effect of each variable and variable interactions on responses including impactor dynamic response, visibility, and internal damage state were determined. The study utilized 32 three-stiffener panels, each with a unique combination of material type, material forms, and structural geometry. Two manufacturing techniques, tow placement and tape lamination, were used to build panels representative of potential fuselage crown, keel, and lower side-panel designs. Various combinations of impactor variables representing various foreign-object-impact threats to the aircraft were examined. Impacts performed at different structural locations within each panel (e.g., skin midbay, stiffener attaching flange, etc.) were considered separate parallel experiments. The relationship between input variables, measured damage states, and structural response to this damage are presented including recommendations for materials and impact test methods for fuselage structure. Author

**N95-28487*# National Aeronautics and Space Administration,
Langley Research Center, Hampton, VA.**

**DAMAGE TOLERANCE OF A GEODESICALLY STIFFENED
ADVANCED COMPOSITE STRUCTURAL CONCEPT FOR
AIRCRAFT STRUCTURAL APPLICATIONS**

MARSHALL ROUSE and DAMODAR R. AMBUR *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 1111-1121 Sep. 1992
Avail: CASI HC A03/MF A04

This paper describes the features of a geodesically stiffened panel concept that was designed for a fuselage application with a combined axial compression loading of 3,000 lb/in. and a shear

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

loading of 600 lb/in. Specimens representative of this panel concept were tested in uniaxial compression both with and without low-speed impact damage to study the buckling and postbuckling response of the structure. Experimental results that describe the stiffness and failure characteristics of undamaged and impacted damage specimens are presented. A finite element analysis model that captures the principal details of the specimens was developed and used to predict the panel response. Analytical results on panel end-shortening are compared with the experimental results. Analytical results that describe panel end-shortening, out-of-plane displacement and stress resultants are presented. Derived from text

N95-28488* Grumman Aerospace Corp., Bethpage, NY. Aircraft Systems.

ADVANCED WING DESIGN SURVIVABILITY TESTING AND RESULTS

J. BRUNO and M. TOBIAS (Naval Air Development Center, Warminster, PA.) In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 1123-1137 Sep. 1992

Avail: CASI HC A03/MF A04

Composite wings on current operational aircraft are conservatively designed to account for stress/strain concentrations, and to assure specified damage tolerance. The technology that can lead to improved composite wing structures and associated structural efficiency is to increase design ultimate strain levels beyond their current limit of 3500 to 4000 micro-in/in to 6000 micro-in/in without sacrificing structural integrity, durability, damage tolerance, or survivability. Grumman, under the sponsorship of the Naval Air Development Center (NADC), has developed a high-strain composite wing design for a subsonic aircraft wing using novel and innovative design concepts and manufacturing methods, while maintaining a state-of-the-art fiber/resin system. The current advanced wing design effort addressed a tactical subsonic aircraft wing using previously developed, high-strain wing design concepts in conjunction with newer/emerging fiber and polymer matrix composite (PMC) materials to achieve the same goals, while reducing complexity. Two categories of advanced PMC materials were evaluated: toughened thermosets; and engineered thermoplastics. Advanced PMC materials offer the technological opportunity to take maximum advantage of improved material properties, physical characteristics, and tailorability to increase performance and survivability over current composite structure. Damage tolerance and survivability to various threats, in addition to structural integrity and durability, were key technical issues addressed during this study, and evaluated through test. This paper focuses on the live-fire testing, and the results performed to experimentally evaluate the survivability of the advanced wing design. Derived from text

N95-28489* Boeing Commercial Airplane Co., Seattle, WA. 777 Empennage Structures.

NASA-ACEE/BOEING 737 GRAPHITE-EPOXY HORIZONTAL STABILIZER SERVICE

J. T. QUINLIVAN, J. A. KENT, and D. R. WILSON In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 1139-1150 Sep. 1992

Avail: CASI HC A03/MF A04

The 737 graphite-epoxy horizontal stabilizer was developed by Boeing as part of the NASA-ACEE (Aircraft Energy Efficiency) Advanced Composite Structures Program. NASA-ACEE programs challenged large-transport manufacturers to use graphite material in redesigning existing aircraft components. The goal of the program was to develop the necessary data and technology to achieve production commitments to advanced composites. Boeing designed, fabricated, and certified five shipsets of horizontal stabilizers for the 737-200 airframe. The program was initiated in July 1977 and certification was achieved in August 1982. Schedule highlights are shown. The work performed on this program is reported in NASA technical summaries and final reports. Boeing introduced the stabilizer into commercial operation in 1984, and has maintained surveil-

lance for seven years of in-service evaluation. Outstanding performance was demonstrated with no service incidents attributed to the graphite-epoxy structure. Boeing will continue to monitor and support these aircraft, adding to the database of commercial composite experience. Derived from text

N95-28504 Duke Univ., Durham, NC. Dept. of Mechanical Engineering and Materials Science.

NONLINEAR DYNAMICS AND AEROELASTICITY OF ROTORCRAFT IN FORWARD FLIGHT Final Report, 1 Aug. 1991 - 31 Jul. 1994

EARL H. DOWELL Feb. 1995 4 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (Contract(s)/Grant(s): DAAL03-91-G-0308)

(AD-A291714; ARO-28493.1-EG) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Large amplitude (nonlinear) oscillations of rotor blades due to self-excitation (flutter) or external excitation (mechanical or aerodynamic) frequently occur and are often design critical for rotorcraft. The present work is a combined theoretical-experimental study to develop improved understanding and mathematical models for enhanced design and performance. DTIC

N95-28567 Defence Science and Technology Organisation, Melbourne (Australia). Aeronautical and Maritime Research Lab. **TIE-DOWN TRIALS INVOLVING A SIKORSKY S-70B-2 HELICOPTER**

JEREMY BLACKWELL Jan. 1995 40 p Original contains color illustrations

(DSTO-TR-0132; AR-008-418) Copyright Avail: Issuing Activity

Two tie-down trials involving a Sikorsky S-70B-2 helicopter are outlined. The first was land-based and utilized a hydraulic tilt table. The second took place on board an FFG-7 frigate. The trials are part of a DSTO (Defense Science and Technology Organization) investigation aimed at improving the tie-down procedures of S-70 B-2 helicopters when operating from ships. A preliminary analysis of the data is presented and indicates that the type of lashing used to secure the helicopter can have a significant effect on the loads transmitted to the fuselage as well as affecting the relative motion of the aircraft. The effect of aircraft brakes on or off was examined and found to result in noticeable differences to the aircraft behavior. During the ship trial, one type of tie-down lashing was observed to suffer from significant slippage through its locking mechanism. Author

N95-28626 Naval Postgraduate School, Monterey, CA. **MODELING HELICOPTER BLADE DYNAMICS USING A MODIFIED MYKLESTAD-PROHL TRANSFER MATRIX METHOD M.S. Thesis**

JUAN D. CUESTA Dec. 1994 74 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289891) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Rotor Blade vibratory stresses are of utmost importance in helicopter design. A modified Myklestad-Prohl method for rotating beams has been coded to assist in preliminary helicopter rotor blade design. The rotor blade dynamics program is part of the Joint Army/Navy Rotorcraft Analysis and Design (JANRAD) program which was developed to aid in the preliminary design and analysis of helicopter rotor performance, stability and control, and rotor dynamics. JANRAD is an interactive, user friendly program written in MATLAB version 4.0 programming language and has been used extensively in the Naval Postgraduate School's capstone helicopter design course (AA 4306). A sample case is run and results are discussed. DTIC

N95-28636# Technische Univ., Delft (Netherlands). **NUMERICAL SIMULATION OF CRACK GROWTH IN PRESSURIZED FUSELAGES Ph.D. Thesis**

H. A. J. KNOPS 26 Sep. 1994 208 p (PB95-192415; ISBN-90-9007413-9) Avail: CASI HC A10/MF A03

The main objective of the present research is to develop a number of tools for the numerical simulation of crack behavior in pressurized fuselages. In these calculations the geometrically non-linear effects described above and the influence of stiffening components on the crack behavior will be taken into account. Since the flapping phenomenon that is observed in experiments on pressurized aircraft fuselages with initially longitudinal cracks is not yet well understood, a major goal of the present research is to simulate crack flapping numerically and to predict whether a crack will flap and at what crack length. In real structures there will always be a plastic zone around the crack tip. However, the behavior of such 'real' cracks is still believed to be dictated by a number of linear elastic crack tip parameters. Therefore in our research we will assume that linear-elastic fracture mechanics conditions hold and that the state of stress around the crack tip is characterized by these linear-elastic crack tip parameters. NTIS

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A95-84567

PART-TASK SIMULATOR EVALUATIONS OF ADVANCED TERRAIN DISPLAYS

JAMES K. KUCHAR Massachusetts Inst. of Tech., MA, US and R. JOHN HANSMAN Massachusetts Inst. of Tech., MA, US *In* Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993. A95-84553 Warrendale, PA Society of Automotive Engineers, Inc. (ISSN) 1993 p. 119-127 Research sponsored by Boeing Commercial Aircraft Co. (SAE PAPER 932570) Copyright

Two studies were performed to investigate human factors issues associated with advanced terrain displays for transport aircraft. The first study investigated three alerting displays (plan, profile, and three-dimensional views) to aid terrain avoidance maneuver performance. Subjects flew through terrain hazard situations on a simulator, and performed escape maneuvers using a sidestick. Each display was found to have limitations, though the data suggest that plan and profile displays may augment each other when used in combination. In the second study, subjects customized terrain resolution levels on a plan view display, and used the display to check for terrain hazards. Subjects preferred the highest available horizontal resolution and 500 ft or 1,00 ft contour separation. Aircraft-relative terrain altitudes allowed faster hazard determination than altitudes relative to mean sea level. Author (Herner)

N95-27003 Wright Lab., Wright-Patterson AFB, OH.

PARTIAL DISCHARGE TESTING OF HIGH VOLTAGE WIRING HARNESS FOR AIRBORNE DISPLAYS Final Report, 15 Dec. 1993 - 15 Feb. 1994

GREGORY L. RHOADS, JOHN HORWATH, and DANIEL SCHWEICKART Oct. 1994 18 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289150; WL-TR-94-2099) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The pilots of advanced tactical airplanes must evaluate increasingly more information. Innovations such as the heads-up display were designed to decrease the visual workload. More flexible helmet-mounted CRT's are now being developed, presenting new design challenges. For example, high voltage leads for helmet-mounted displays must incorporate a quick release, load-break mechanism into the wiring harness to accommodate pilot ejection. The potential presence of flammable vapors resulted in an arc-suppressing, quick-disconnect connector design which opens the high voltage via hermetically sealed contacts. The sealed contacts contain any arcing and break the circuit before the connector separates. The prototype harness routes two 13.5 kilovolt rated

direct current leads along with other wiring via the quick-disconnect connector. The high voltage and compact design motivate concerns about partial discharge degradation of the insulation, particularly at sub-atmospheric pressures. The harness has been tested for partial discharges at simulated altitudes up to 70,000 feet in the Aerospace Power Division's High Power Laboratory. DTIC

N95-28203*# Georgia Inst. of Tech., Atlanta, GA. Center of Human-Machine Systems Research.

OPERATOR MODELING IN COMMERCIAL AVIATION: COGNITIVE MODELS, INTELLIGENT DISPLAYS, AND PILOT'S ASSISTANTS Final Report, 1 Jul. 1990 - 30 Apr. 1994

T. GOVINDARAJ and C. M. MITCHELL 30 Apr. 1994 22 p (Contract(s)/Grant(s): NCC2-675) (NASA-CR-198609; NAS 1.26:198609) Avail: CASI HC A03/MF A01

One of the goals of the National Aviation Safety/Automation program is to address the issue of human-centered automation in the cockpit. Human-centered automation is automation that, in the cockpit, enhances or assists the crew rather than replacing them. The Georgia Tech research program focused on this general theme, with emphasis on designing a computer-based pilot's assistant, intelligent (i.e. context-sensitive) displays, and an intelligent tutoring system for understanding and operating the autoflight system. In particular, the aids and displays were designed to enhance the crew's situational awareness of the current state of the automated flight systems and to assist the crew's situational awareness of the current state of the automated flight systems and to assist the crew in coordinating the autoflight system resources. The activities of this grant included: (1) an OFMSPert to understand pilot navigation activities in a 727 class aircraft; (2) an extension of OFMSPert to understand mode control in a glass cockpit, Georgia Tech Crew Activity Tracking System (GT-CATS); (3) the design of a training system to teach pilots about the vertical navigation portion of the flight management system -VNAV Tutor; and (4) a proof-of-concept display, using existing display technology, to facilitate mode awareness, particularly in situations in which controlled flight into terrain (CFIT) is a potential. Derived from text

N95-28586 Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Logistics and Acquisition Management.

LIFE CYCLE COSTS OF ALTERNATIVES FOR F-16 PRINTED CIRCUIT BOARD DIAGNOSIS EQUIPMENT M.S. Thesis

KENT R. MONTGOMERY and CLIFFORD B. THORSTENSON Dec. 1994 53 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A288744; AFIT/GSS/LAR/94D-3) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This study analyzes two alternatives for printed circuit board (PCB) diagnosis for the F-16 depot PCB repair shop from a life cycle cost (LCC) perspective. Alternative 1 assumes the use of the current F-16 automatic test equipment (ATE) while Alternative 2 augments the current ATE with infrared imaging test equipment. Infrared imaging is a developed technology that is currently available to the Air Force in a commercial-off-the-shelf (COTS) form. Using the Cost Analysis and Strategy Assessment (CASA) Life Cycle Cost (LCC) Model and data from the DL41 database on F-16 PCB's this study determined that over the current expected life of the F-16, the next twenty-five years, a savings of approximately \$1.1 million (1994 dollars) can be realized by augmenting the current F-16 ATE with infrared imaging test equipment 15% of the F-16 printed circuit boards (PCB's) are single card PCB's which can be tested using infrared imaging test. This study assumes that the total number of PCB's and the percentage of single card PCB's does not change over the F-16's lifetime. Sensitivity analyses are performed varying the percentage of single card PCB's, the total number of PCB's and the F-16 lifetime to determine the effects these changes might have on the total life cycle cost of Alternative 2. DTIC

AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

A95-82321

EVALUATION OF SCRAMJET NOZZLE PERFORMANCE

TOHRU MITANI Kakuda Research Center, Kakuda, Miyagi, Japan, SHUICHI UEDA Kakuda Research Center, Kakuda, Miyagi, Japan, KOUICHIRO TANI Kakuda Research Center, Kakuda, Miyagi, Japan, SHIGERU SATO Kakuda Research Center, Kakuda, Miyagi, Japan, MASASHI MATSUMOTO Ishikawajima-Harima Heavy Industry Co. Ltd., Nishitama, Tokyo, Japan, and MASAHICO YAMAMOTO Ishikawajima-Harima Heavy Industry Co. Ltd., Nishitama, Tokyo, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 169-176*

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Thrust by scramjet nozzles was measured using high temperature gas flow with a Mach number of 2.5 and a total temperature of 3100 K produced by combustion of monomethyl hydrazine (MMH) and nitrogen tetroxide (NTO). Wall pressure in the nozzles was monitored at more than 150 points to estimate the pressure force in the nozzles in order to validate experimental techniques and numerical codes. A series of cold nitrogen (N₂) flow tests was also considered using the same nozzle. Friction in the nozzles was estimated by heat flux and Pitot pressure distribution. An inviscid two-dimensional kinetic code was able to reproduce nozzle performance of cold N₂ flow within a discrepancy of 6.6%. The calculation also agreed with the experimental results on hot MMH/NTO flow within an error of 3.6% if the energy release loss in the gas generator was taken into account. Kinetic, two-dimensional and friction losses in scram nozzles were identified for the nozzle. Author (Hemer)

A95-82322

AN EXPERIMENTAL INVESTIGATION OF SCRAMJET NOZZLE FLOW

SHIGEYA WATANABE National Aerospace Laboratory, Chofu, Tokyo, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 177-182*

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An experimental study of scramjet nozzle flowfields is conducted to investigate effects of interaction of an engine exhaust with a hypersonic external flow on nozzle performance. Tests are performed in the National Aerospace Laboratory (NAL) hypersonic wind tunnel with $M(\infty) = 7.1$, whose freestream constitutes the external flow. Room temperature air is used as the simulated engine exhaust flow. Measurement of model surface pressure and flow visualizations are performed. Test results indicate that the external flow affects the model surface pressure only from the sides and aft end of the ramp because the intercepting shock does not impinge upon the ramp surface. It is also shown that the external flow suppresses the boundary layer separation on the ramp surface. By using long side fences, a slight gain of thrust can be obtained relative to the case using short side fences. The estimated nozzle performance by the 2-D 'method of characteristics' with boundary layer correction agrees well with the experimental result in the case using the long side fences. Author (Hemer)

A95-82323

PREDICTION OF PRE-COMBUSTION SHOCK IN SCRAMJET COMBUSTORS: A NEW METHOD

NOBUO CHINZEI Kakuda Research Center, Miyagi, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299*

Tokyo, Japan ISTS Editorial Board 1992 p. 183-188

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A new method to predict the strength of a pre-combustion shock, which appears at the entrance of scramjet combustors, was developed. The formulation consists of integration of three-dimensional steady inviscid conservation equations for axial momentum and mass over the combustor cross section, together with an assumption of unequal pressures between the combustor wall and the cross sectional average. These lead to a different form of the axial momentum equation and an additional variable (wall pressure) compared with the conventional one-dimensional equations. A constraint condition on the variation of entropy was applied to cope with an increased number of variable. In addition to the effect of the entrance Mach number, derived model can predict those of combustor geometry and heat release gradient at the entrance on the strength of pre-combustion shock, which has not been possible to predict by the previous methods, including widely used Billig's model. Author (Hemer)

A95-82325

AN ADVANCED SCRAMJET PROPULSION CONCEPT FOR A 350 MG SSTO SPACE PLANE

KUNIHISA EGUCHI Space Technology Research Group, Chofu, Tokyo, Japan, TSUTOMU FUJIWARA Space Technology Research Group, Chofu, Tokyo, Japan, TATSUO YAMANAKA Space Technology Research Group, Chofu, Tokyo, Japan, TATSURU TOKUNAGA Mitsubishi Heavy Industries Ltd., Komaki, Aichi, Japan, YOICHIRO MIKI Mitsubishi Heavy Industries Ltd., Komaki, Aichi, Japan, and MORITO TOGAWA Mitsubishi Heavy Industries Ltd., Komaki, Aichi, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 197-204*

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The scramjet engine plays an important role on the ascent-phase acceleration of a single-stage-to-orbit (SSTO) hypersonic vehicle, entitled 'Space Plane,' over a flight speed of more than Mach 5. The purpose of the present study is to provide a design methodology for an advanced hydrogen-fueled scramjet engine for a vehicle with an SSTO hypervelocity beyond flight Mach 20 and a takeoff gross weight of 350 MG. A sophisticated analysis has been attempted to see how the propulsion performance can be improved by an effective conversion of available energy into thrust momentum with hot hydrogen injection. It is concluded that the amount of energy required for regenerative cooling of the engine is much larger than the external drag energy loss for higher flight speeds. Furthermore, in such a scramjet operation the high hydrogen thrust resulting from the fuel cooling of airborne and engine is of much importance to avoid excessive deceleration of combustion gas flow because of the momentum loss due to the internal drag. It is also expected that a 350 MG SSTO space plane with such an advanced SCRAM-LACE propulsion will be feasible in the 21st century. Author (Hemer)

A95-82327

TEST RESULTS ON AIR TURBO RAMJET ENGINE FOR A FUTURE SPACE PLANE

NOBUHIRO TANATSUGU Institute of Space and Astronautical Science, Yoshinodai, Sagami-hara, Japan, YOSHIHIRO NARUO Institute of Space and Astronautical Science, Yoshinodai, Sagami-hara, Japan, and ITARU ROKUTANDA Ishikawajima-Harima Heavy Industries Co., Ltd, Tanashi, Tokyo, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 211-216*

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The Institute of Space and Astronautical Science (ISAS) has been engaged in the development study on the Air Turbo Ramjet (ATR) engine since 1986 in cooperation with the Ishikawajima Harima Heavy Industries Co., Ltd. (IHI). The ATR is one of the most preferable candidates for the propulsion system of a future space plane. Our ATR engine is the combined cycle air breathing propul-

sion system, which consists of the turbojet and the fan boosted ramjet using the liquid hydrogen as a fuel. This engine system was named 'ATREX' after employing the expander cycle. The ATREX is energized by thermal energy extracted regeneratively in both the pre-cooler installed in air intake and the heat exchanger in combustion chamber. The ATREX works in the flight condition from sea level static up to Mach 6 at 35 km altitude. The ATREX employs the tip turbine configuration for compactness of turbo machinery. We are assessing the feasibility of ATREX system by the sea level static tests using the 1/4-scale model (ATREX-500) with fan inlet diameter of 300 mm and overall length of 2,120 mm. In 1990, the ATREX-500 engine was tested in sea level static condition to verify the performance characteristics of the turbo machinery and the combustor. In September of 1991, the heat exchanger was installed in the combustion chamber and tested independently of the turbo system. In November of 1991, the heat exchanger was coupled with the turbo system and tested to verify the overall system of the ATREX. The test results of the ATREX-500 engine tested in the sea level static condition are presented here. Author (Hemer)

A95-82337

LIFE EVALUATION OF A LOW POWER ARCJET THRUSTER
SHUICHI TSURI Osaka University, Osaka, Japan, KEN-ICHI ONOE Osaka University, Osaka, Japan, TAKAO YOSHIKAWA Osaka University, Osaka, Japan, MASAHIRO ISHII Ishikawajima Harima Heavy Industries Co. Ltd., Kanagawa, Japan, and KAZUO UEMATSU Ishikawajima Harima Heavy Industries Co. Ltd., Kanagawa, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 287-295 Copyright*

The present experiments are conducted with a radiation cooled arcjet thruster (RAT-V), which has been developed in Osaka University. It uses a 2:1 mixture of hydrogen and nitrogen as propellant in the following operational conditions: the mass flow rate is 30 mg/s, discharge current 11 A, input power 1.1 kW, and specific impulse 500 sec. In the same operational conditions, the previous test results showed that the anode damage was hardly observed after the continuous test for 30 hours. The tests are as follows: (1) The cyclic start-up test of 1000 times; (2) The steady-state test for 30 hours making use of the eroded anode after the test of (1). The results of the test of (1) showed that the exit diameter of the constrictor was hardly magnified, though the anode erosion at the plenum chamber side was observed; the measured anode and cathode losses were 7.5 micro-g/cycle and 3.2 micro-g/cycle, respectively. The result of thrust measurement after the test of (1) showed no degradation in performance. In the continuous of (2), no low voltage operation occurred and the anode hardly sustained damage. Consequently, the anode may be able to endure the cyclic operation over 1000 hours with 1000 restarts which is required for the north-south stationkeeping. But cathode degradation due to cathode erosion may bring about the increase of the discharge voltage and difficulty of the start-up. Author (Hemer)

A95-82420

EXPERIMENT AND ANALYSIS ON HEAT TRANSFER OF A SCRAMJET LEADING EDGE MODEL
SHUICHI UEDA National Aerospace Laboratory, Miyagi, Japan, TOSHIHITO SAITO National Aerospace Laboratory, Miyagi, Japan, NOBORU SAKURANAKA National Aerospace Laboratory, Miyagi, Japan, KATSUHIRO ITOH National Aerospace Laboratory, Miyagi, Japan, YOSHIO WAKAMATSU National Aerospace Laboratory, Miyagi, Japan, and KIYAMU IMAI Ishikawajima-Harima Heavy Industries, Tokyo, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 823-830 Copyright*

Heating tests and analysis of a cooling panel that simulates the leading edge of the scramjet engine inlet or strut were performed. A

crossflow type water-cooled panel having a circular leading edge was selected. The cooling panel was fabricated by nickel electroforming and heated by supersonic hot gas. A nitrogen tetroxide (NTO)/monomethylhydrazinium (MMH) rectangular chamber was used as the gas generator. The free stream Mach number at the nozzle exit was about 2.67. Water was used as the coolant and heat flux distribution was measured based on the temperature increase. Thermal analyses were performed using a two-dimensional computational fluid dynamics (CFD) code and a finite element code. The results of analyses were compared with experimental data.

Author (Hemer)

A95-82680

STUDIES ON PLASMA JET IGNITERS

HIDEYUKI HORISAWA Tokai Univ., Kanagawa, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 2541-2545 Copyright*

Studies on the ignition performance by low-power upstream injection plasma jets were conducted for H₂ fuel jets in highspeed air streams. The plasma jets, which produce chemically active species by means of electric discharges, were operated at relatively low electric power, and Ar gas involving active additive gas such as O₂, N₂ or H₂ was used as the feedstock. The combustor consisted of a rearward-facing step for flame stabilization and a fuel injector downstream of the step, and the igniters were tested in the various operational conditions (i.e. electric power, active gas content in feedstock, air stream velocity, injection position of plasma jet, etc.). It was observed that for ignition concentration of active gases in the feedstock was more important than plasma jet power, suggesting that role of active species supplied from the plasma jet was dominant than that of thermal energy. Author (Hemer)

A95-84196

AIRCRAFT GAS TURBINE EMISSIONS CHALLENGE

B. L. KOFF Pratt & Whitney, West Palm Beach, FL, United States *Journal of Engineering for Gas Turbines and Power, Transactions of the ASME (ISSN 0742-4795) vol. 116, no. 3 July 1994 p. 474-477 (BTN-94-EIX95011441239) Copyright*

The new generation of jet powered aircraft faces a significant challenge to reduce pollutant emissions while increasing fuel efficiency. Carbon monoxide (CO) and unburned hydrocarbon (HC) emissions are already very low and continued control of these pollutants is expected as engine temperatures and pressure ratios are increased. In contrast, significant system design improvements are needed to reduce oxides of nitrogen (NO_x) emissions because of their harmful effect on the earth's ozone layer. This paper discusses the prospects and technical approaches for significant NO_x reductions in current and future subsonic and supersonic aircraft. Author (EI)

A95-84197

NITROGEN OXIDE EMISSIONS CHARACTERISTICS OF AUGMENTED TURBOFAN ENGINES

S. P. SETO GE Aircraft Engines, Cincinnati, OH, United States and T. F. LYON *Journal of Engineering for Gas Turbines and Power, Transactions of the ASME (ISSN 0742-4795) vol. 116, no. 3 July 1994 p. 478-482 refs (BTN-94-EIX95011441240) Copyright*

The exhaust plumes of modern military engines can be rendered visible at low augmentor power operation by the presence of nitrogen dioxide (NO₂). Visible plumes have also been observed from some industrial gas turbines that have duct burners downstream of the power turbines. In 1986, gaseous emissions measurements were taken behind two F101 turbofan engines to determine the effect of reheat level on the degree of conversion of nitric oxide (NO) to nitrogen dioxide and to relate the plume visibility to nitrogen dioxide concentration. Author (EI)

A95-84784

NASA-LEWIS TESTS ALLISON ASTOVL NOZZLE

STANLEY W. KANDBO Aviation Week & Space Technology (ISSN 0005-2175) vol. 140, no. 19 May 9, 1994 p. 80 (HTN-95-20603) Copyright

This article describes a telescoping vectoring nozzle developed by Allison Engine Company for the Advanced Short Takeoff and Vertical Landing (ASTOVL) program and tested by NASA Lewis Research Center. Performance tests include validating the nozzle's flow and thrust coefficients against values calculated using computational fluid dynamics (CFD) codes. Hemer

A95-84909

THE EFFECTS OF SURFACE MODIFICATION ON FRETTING FATIGUE IN TI ALLOY TURBINE COMPONENTS

S. CHAKRAVARTY Hawker Siddeley Canada, Orenda Division, Canada, R. G. ANDREWS Hawker Siddeley Canada, Orenda Division, Canada, P. C. PATNAIK Hawker Siddeley Canada, Orenda Division, Canada, and A. K. KOUL SMPL-IAR National Research Council, Ottawa, Canada JOM (ISSN 1047-4838) vol. 47, no. 4 April 1995 p. 31-35 Research sponsored by the Department of National Defence Canada (HTN-95-61145) Copyright

Severe fretting damage has been observed on the pressure surfaces of fan and compressor blade dovetails/disks in an aerospace gas turbine engine. A study has been carried out to evaluate the effects of an ion implantation technique in combination with the presently used surface treatments, such as shot peening and coating, on the fretting fatigue life of titanium alloy gas turbine engine components. The results from fretting fatigue tests, residual stress measurements, and nano-indentation tests were used to quantitatively evaluate the effect of various surface treatments on the fretting fatigue life of the fan blade and disk materials. Results from microstructural characterization and analyses of elemental and phase distributions within the implanted region are used to understand the effect of ion implantation on the surface properties of the alloys. Finally, an attempt has been made to evaluate the potential for improving the fretting fatigue life of the engine components using various surface modification techniques. Author (Hemer)

A95-85060

ARTIFICIAL NEURAL NETWORKS FOR PREDICTING NONLINEAR DYNAMIC HELICOPTER LOADS

A. B. COOK Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, US, C. R. FULLER Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, US, W. F. O'BRIEN Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, US, and R. H. CABELL Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 5 May 1994 p. 1072-1077 Research sponsored by the U.S. Army Aviation Applied Technology Directorate (HTN-95-51678) Copyright

The fatigue life of dynamic helicopter components is highly dependent on the history of loads experienced by the components during flight. However, practical methods of monitoring the loads on individual components during flight have not been developed. Current maintenance programs are characterized by frequent inspections and sometimes premature retirement of safety-critical components. This paper proposes using an artificial neural network (ANN) to predict the loads in critical components based on flight variable information than can be easily measured. The artificial neural network learns the relationship between flight variables and component loads through exposure to a database of flight variable records and corresponding load histories taken from an instrumented military helicopter undergoing standard maneuvers. Eight standard flight variables are used as inputs for predicting the time-varying mean and oscillatory components of the tailboom bending load and the pitch link load for seven flight maneuvers. The ANN predicts the mean and oscillatory components with accuracy ranging from 90.7% to 97.7% correct. Author (Hemer)

A95-85357

ARTIFICIAL INTELLIGENCE FOR TURBOPROP ENGINE MAINTENANCE

G. TORELLA and G. LOMBARDO Aerospace Engineering (ISSN 0736-2536) vol. 15, no. 1 January-February 1995 p. 27-31 (HTN-95-92313) Copyright

The most significant activity performed during the life of gas turbines is maintenance. Engine dependability and integrity depend strongly on correct, effective maintenance. Also, control of human and financial resources for maintenance keeps the process efficient. Artificial intelligence can be used to improve maintenance and its efficiency without causing a sharp increase in cost. Two areas of artificial intelligence show promise for turboprop engine maintenance. They are expert systems and neural networks. Hemer

A95-85990

APPLYING NANOSTRUCTURED MATERIALS TO FUTURE GAS TURBINE ENGINES

MAURICE GELL Univ. of Connecticut, Storrs, CT, US JOM (ISSN 1047-4838) vol. 46, no. 10 October 1994 p. 30-34 (HTN-95-11909) Copyright

The need for improved materials to provide increased gas turbine engine performance is as great today as at any time in the 50-year history of this field. The emerging technology of nanostructured materials holds the potential for satisfying the gas turbine industry's requirements with a new generation of materials possessing a quantum improvement in properties. In the laboratory, significant increases in strength and hardness combined with toughness and ductility have been demonstrated. Additionally, desirable physical properties such as enhanced diffusivity and reduced thermal conductivity have been found. In the following article, an aggressive and focused technology development strategy is described that will allow an early assessment of this promising technology for year 2000 gas turbine applications. Author (Hemer)

A95-86158

GENERAL SOLUTION PROCEDURE FOR FLOWS IN LOCAL CHEMICAL EQUILIBRIUM

CAREY F. COX Mississippi State University, Mississippi State, MS, US and PASQUALE CINNELLA Mississippi State University, Mississippi State, MS, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 519-527 Research sponsored by the National Science Foundation (Contract(s)/Grant(s): F08635-89-C-0208) (HTN-95-42329) Copyright

This study details the derivation and application of an approximate Riemann solver of the Roe type specifically designed for the numerical simulation of inviscid and viscous flow problems involving general and virtually arbitrary mixtures of thermally perfect gases in local chemical equilibrium. The solution procedure is by no means limited to airflows and will be applied to an oxygen/hydrogen mixture as well. A 'black box' solver for the local equilibrium composition of a gas mixture of known density and internal energy is coupled with the flow solver, which is based on the newly derived flux-difference-split technique. A few test cases, including both external and internal flows, illustrate the capabilities and the overall efficiency of the flow solver. Author (Hemer)

A95-86159* National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

QUANTITATIVE INVESTIGATION OF COMPRESSIBLE MIXING: STAGED TRANSVERSE INJECTION INTO MACH 2 FLOW

STEVEN D. HOLLO University of Virginia, Charlottesville, VA, US, JAMES C. MCDANIEL University of Virginia, Charlottesville, VA, US, and ROY J. HARTFIELD, JR. University of Virginia, Charlottesville, VA, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 528-534 (Contract(s)/Grant(s): NAS1-795) (HTN-95-42330) Copyright

Planar measurements of the injectant mole fraction distribution and the velocity field within a supersonic mixing flowfield have been made using laser-induced iodine fluorescence. The flowfield investigated in this work is staged transverse injection of air into a Mach 2 freestream. A complete three-dimensional survey of the injectant mole fraction distribution has been generated, and a single planar velocity measurement has been completed. The measurements reveal the dramatic effect of streamwise vortices on the mixing in the near field of the injectors, as well as the rapid mixing generated by staging two fuel injectors. Analysis of the downstream decay of the maximum injectant mole fraction in this and other supersonic mixing flowfields indicates that the relative rate of injectant mixing well downstream of the injectors is independent of injection geometry, freestream Mach number, and injectant molecular weight. Mixing within this region of the flowfield is dominated by small-scale turbulence within the injectant plume. The transition of the dominant mixing mechanism, from vortex-driven mixing in the near field to small-scale turbulent mixing in the far field, was found to occur in the region about 10 diameters downstream of the injectors. Author (Herner)

A95-86166
FLOWFIELD MEASUREMENTS IN SUPERSONIC FILM COOLING INCLUDING THE EFFECT OF SHOCK-WAVE INTERACTION

K. A. JUHANY California Institute of Technology, Pasadena, CA, US and M. L. HUNT California Institute of Technology, Pasadena, CA, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 578-585

(HTN-95-42337) Copyright

A study has been made to investigate the flowfield of supersonic slot injection and its interaction with a two-dimensional shock wave. Air and helium were injected at Mach numbers of approximately 1.3 and 2.2 into an airstream of Mach 2.4. Measurements of the total pressure profiles perpendicular to the wall were made at several axial locations, the farthest being at 90 slot heights. The profiles provided details of the structure of the flow for different injection conditions. With heated gas injection, experiments were conducted to determine the adiabatic wall temperatures and the wall static pressures. These measurements were then repeated with the impingement of two-dimensional shock waves at 60 slot heights downstream of the slot. The shock strengths were chosen to illustrate the differences between separated and attached flows. The shock strength that produced incipient separation was found to be smaller when helium was injected than when no film coolant was present. Conversely, the shock strength that produced incipient separation with air injection was slightly larger than that obtained without film cooling. Author (Herner)

A95-86255
AEROELASTIC STABILITY OF CASCADES IN TURBOMACHINERY

H. FOERSCHING German Aerospace Research Establishment, Goettingen, Germany Progress in Aerospace Sciences (ISSN 0376-0421) vol. 30, no. 3 1994 p. 213-266

(HTN-95-61156) Copyright

State-of-the-art prediction of the aeroelastic stability of cascades in axial-flow turbomachines is reviewed. The first main chapter of the article presents a comprehensive formulation of the two- and three-dimensional classical (unstalled) flutter problem of tuned and mistuned rotor blade rows and bladed disc assemblies. Within the framework of linearized analysis, a complete and generalized theory in modal form is outlined, comprising the various formulations of the cascade flutter problem distributed in fragments throughout the literature. Brief outlines are also made of recent advances in unsteady aerodynamic methods for turbomachinery aeroelastic applications. The second main chapter contains a parametric study of the classical flutter stability characteristics of compressor and turbine cascades in subsonic and supersonic flow. Stability boundaries and dominant trends in flutter behaviour are outlined, and the significant effects of blade mistuning on the aeroelastic stability of turbomachine bladings are highlighted. Author (Herner)

N95-26412* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

SIMULATION MODEL OF THE INTEGRATED FLIGHT/PROPULSION CONTROL SYSTEM, DISPLAYS, AND PROPULSION SYSTEM FOR ASTOVL LIFT-FAN AIRCRAFT
 W. Y. WILLIAM CHUNG, PAUL F. BORCHERS, and JAMES A. FRANKLIN Apr. 1995 50 p

(Contract(s)/Grant(s): RTOP 505-68-32)

(NASA-TM-108866; A-950048; NAS 1.15:108866) Avail: CASI HC A03/MF A01

A simulation model has been developed for use in piloted evaluations of takeoff, transition, hover, and landing characteristics of an advanced, short takeoff, vertical landing lift fan fighter aircraft. The flight/propulsion control system includes modes for several response types which are coupled to the aircraft's aerodynamic and propulsion system effectors through a control selector tailored to the lift fan propulsion system. Head-up display modes for approach and hover, tailored to their corresponding control modes are provided in the simulation. Propulsion system components modeled include a remote lift and a lift/cruise engine. Their static performance and dynamic response are represented by the model. A separate report describes the subsonic, power-off aerodynamics and jet induced aerodynamics in hover and forward flight, including ground effects. Author

N95-26424 Defence Science and Technology Organisation, Melbourne (Australia). Aeronautical and Maritime Research Lab.

CHARACTERISTICS OF THE TURBINE INLET TEMPERATURE SENSING CIRCUIT FOR THE T56 TURBO-PROP ENGINE

K. F. FRASER Nov. 1994 57 p

(DSTO-TR-0095; AR-008-374) Copyright Avail: Issuing Activity (DSTO, Melbourne Victoria, Australia)

The temperature to voltage transfer characteristics of the standard turbine inlet temperature averaging sensor for the T56 turbo-prop engine are derived using measured resistance parameters for the 18-thermocouple network. The transfer characteristics of an add-on individual thermocouple temperature sensing circuit are also derived and some of the requirements of the associated signal conditioning circuit are briefly reviewed. Author

N95-26600# National Aerospace Lab., Tokyo (Japan). Ramjet Propulsion Research Div.

EXPERIMENT ON A RECTANGULAR CROSS SECTION SCRAMJET COMBUSTOR. 2: EFFECTS OF FUEL INJECTOR GEOMETRY

ATSUO MURAKAMI, TOMOYUKI KOMURO, and KENJI KUDOU Dec. 1993 27 p In JAPANESE

(ISSN 0389-4010)

(NAL-TR-1220) Avail: CASI HC A03/MF A01

An experimental study of a rectangular cross section scramjet combustor was carried out. The effects on mixing and combustion performances of the rearward-facing steps, fuel injection orifice arrangements and the length of the constant height section downstream of the step were examined. The peak wall pressure, namely the strength of the precombustion shock, increased as the length of the constant height section downstream of the injection orifices increased. The injected fuel jets coalesced if the precombustion shock was too strong, while they stratified if it was too weak. Hence the mixing and combustion efficiencies of these two cases were low. To achieve better fuel mixing, the length of the constant height section must be selected so that it gives the most suitable strength of the precombustion shock. Sweep of the rearward-facing steps and the orifice arrangements had little effect on the mixing and combustion efficiencies. Author

N95-26706# National Aerospace Lab., Tokyo (Japan). Ramjet Propulsion Research Div.

EFFECTS OF DUST FROM STORAGE HEATERS ON IGNITION IN SCRAMJETS

Apr. 1994 20 p In JAPANESE

(ISSN 0389-4010)

(NAL-TR-1234) Avail: CASI HC A03/MF A01

The effect of dust on ignition delay in ground-testing of scramjet engines was investigated analytically. Incandescent particles issued from a storage air heater cause premature ignition of H₂ - fuel injected into the combustor. In order to prevent erroneous experimental results, the concentration of particles greater than about 40 microns in size must be restricted to less than 10(exp 3) particles/m(exp 3). The thermal and chemical inhibition effects due to fine particles can be neglected in engine testing, if the mass fraction of dust in the heated air is less than 10(exp -1) in the wind tunnel. This analysis is applicable to the mechanism of powdered flame suppressants. Author

N95-26777*# MCAT Inst., San Jose, CA.

TURBOMACHINERY DESIGN AND TONAL ACOUSTICS COMPUTATIONS Final Report, Jun. 1993 - Jan. 1995

AKIL A. RANGWALLA Jan. 1995 53 p Original contains color illustrations

(Contract(s)/Grant(s): NCC2-767)

(NASA-CR-197749; NAS 1.26:197749; MCAT-95-17) Avail: CASI HC A04/MF A01; 2 functional color pages

The objective of this research was two-fold. The first objective was to complete the three-dimensional unsteady calculations of the flow through a new transonic turbine and study the effects of secondary flows due to the hub and casing, tip clearance vortices, and the inherent three-dimensional mixing of the flow. It should be noted that this turbine was and is still in the design phase and the results of the calculations have formed an integral part of the design process. The second objective of this proposal was to evaluate the capability of rotor-stator interaction codes to calculate tonal acoustics. Derived from text

N95-26878 Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

STALL PRECURSOR STUDY OF HIGH FREQUENCY DATA FOR THREE HIGH SPEED, SWEEP COMPRESSOR ROTORS M.S. Thesis

JAMES F. ANDERTON Dec. 1994 165 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(AD-A289379; AFIT/GAE/ENY/94D-13) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The frequency spectra of three single stage, high speed compressor rotors were derived and analyzed from experimental data. The compressor rotors included straight, backward-swept, and forward-swept blade designs. Data was acquired from four pressure transducers located on the compressor casing and arranged axially between locations 40% of blade chord upstream of the rotor face to just over the leading edge of the blades. Each rotor was throttled to stall at two constant speeds between 90% and 100% of design speed. Data digitization at 20 kHz revealed multiples of the rotor frequency up to and beyond a dominant blade passing frequency. Further analyses for characteristics of impending stall included examination of integrated signal power and cross-correlations of transducer signals from the upstream and downstream-most pressure transducers. Results of the integrated signal power approach showed promise as a potential pre-stall warning. This technique detected differences in the signal power at the two transducers in the immediate pre-stall time frame. Pre-stall warning times varied from several seconds to less than 0.5 second, with higher rotor speeds giving less warning time. Results for the forward-swept rotor, however, showed that integrated signal power did not warn of impending stall, and that surge energies played an important role in this rotor's stalling characteristics. An hypothesis for the behavior of the forward swept rotor, based on the possibility of stall development beginning in the near-hub radial region of this compressor, was developed. DTIC

N95-27860*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

OPTIMIZATION OF WAVE ROTORS FOR USE AS GAS TURBINE ENGINE TOPPING CYCLES

JACK WILSON (NYMA, Inc., Brook Park, OH.) and DANIEL E. PAXSON Jun. 1995 11 p Presented at the 1995 Aerospace Atlantic Conference and Exposition, Dayton, OH, 23-25 May 1995; sponsored by SAE

(Contract(s)/Grant(s): NAS3-27186; RTOP 505-90-58)

(NASA-TM-106951; E-9689; NAS 1.15:106951) Avail: CASI HC A03/MF A01

Use of a wave rotor as a topping cycle for a gas turbine engine can improve specific power and reduce specific fuel consumption. Maximum improvement requires the wave rotor to be optimized for best performance at the mass flow of the engine. The optimization is a trade-off between losses due to friction and passage opening time, and rotational effects. An experimentally validated, one-dimensional CFD code, which includes these effects, has been used to calculate wave rotor performance, and find the optimum configuration. The technique is described, and results given for wave rotors sized for engines with sea level mass flows of 4, 26, and 400 lb/sec. Author

N95-27866*# Allison Engine Co., Indianapolis, IN.

PROPULSION SYSTEM ASSESSMENT FOR VERY HIGH UAV UNDER ERAST Final Report

JAMES L. BETTNER, CRAIG S. BLANDFORD, and BERNIE J. REZY Cleveland, OH NASA May 1995 156 p

(Contract(s)/Grant(s): NAS3-25950; RTOP 537-10-20)

(NASA-CR-195469; E-9653; NAS 1.26:195469; EDR-17199) Avail: CASI HC A08/MF A02

A series of propulsion systems were configured to power a sensor platform to very high altitudes under the Experimental Research Advanced Sensor Technology (ERAST) program. The unmanned aircraft was required to carry a 100 kg instrument package to 90,000 ft altitude, collect samples and make scientific measurements for 4 hr, and then return to base. A performance screening evaluation of 11 propulsion systems for this high altitude mission was conducted. Engine configurations ranged from turboprop, spark ignition, two- and four-stroke diesel, rotary, and fuel cell concepts. Turbo and non-turbo-compounded, recuperated and nonrecuperated arrangements, along with regular JP and hydrogen fuels were interrogated. Each configuration was carried through a preliminary design where all turbomachinery, heat exchangers, and engine core concepts were sized and weighed for near-optimum design point performance. Mission analysis, which sized the aircraft for each of the propulsion systems investigated, was conducted. From the array of configurations investigated, the propulsion system for each of three different technology levels (i.e., state of the art, near term, and far term) that was best suited for this very high altitude mission was identified and recommended for further study. Author

N95-28227*# McDonnell-Douglas Corp., Saint Louis, MO.

PERFORMANCE STUDY FOR INLET INSTALLATIONS

DONALD C. BINGAMAN Nov. 1992 94 p

(Contract(s)/Grant(s): NAS1-19462; RTOP 505-68-70-06)

(NASA-CR-189714; NAS 1.26:189714) Avail: CASI HC A05/MF A01

A conceptual design trade study was conducted by McDonnell Aircraft Company (MCAIR) and NASA LARC PAB to determine the impact of inlet design features incorporated for reduced detectability on inlet performance, weight, and cost, for both fighter and attack-type aircraft. Quality Function Deployment (QFD) techniques were used to prioritize trade study issues, and select 'best' air induction system configurations for each of two notional aircraft, the Multi-Role Fighter (MRF) and the Advanced Medium Attack (AMA) bomber. Database deficiencies discovered in the trade study process were identified, and technology roadmaps were developed to address these deficiencies. Finally, two high speed inlet wind tunnel model concepts were developed for follow-on wind tunnel investigations. Author

N95-28275*# Pratt and Whitney Aircraft Group, West Palm Beach, FL.

COMPOSITE INTERMEDIATE CASE MANUFACTURING SCALE-UP FOR ADVANCED ENGINES

ROWENA H. ECKLUND In FAA, Ninth DOD/NASA/FAA Confer-

ence on Fibrous Composites in Structural Design, Volume 3 p 1289-1302 Sep. 1992
(Contract(s)/Grant(s): F33615-85-C-5152)
Copyright Avail: CASI HC A03/MF A04

This Manufacturing Technology for Propulsion Program developed a process to produce a composite intermediate case for advanced gas turbine engines. The method selected to manufacture this large, complex part uses hard tooling for surfaces in the airflow path and trapped rubber to force the composite against the mold. Subelements were manufactured and tested to verify the selected design, tools, and processes. The most significant subelement produced was a half-scale version of a composite intermediate case. The half-scale subelement maintained the geometry and key dimensions of the full-scale case, allowing relevant process development and structural verification testing to be performed on the subelement before manufacturing the first full-scale case. Author

N95-28277* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ANALYSIS OF AIRCRAFT ENGINE BLADE SUBJECT TO ICE IMPACT

E. S. REDDY (Sverdrup Technology, Inc., Brook Park, OH.), G. H. ABUMERI (Sverdrup Technology, Inc., Brook Park, OH.), C. C. CHAMIS, and P. L. N. MURTHY In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 3 p 1319-1331 Sep. 1992 Previously announced as N92-15402
Copyright Avail: CASI HC A03/MF A04

The ice impact problem on an engine blade made of layered composite is simulated. The ice piece is modeled as an equivalent spherical object and has the velocity opposite to that of the aircraft with direction parallel to the engine axis. Near the impact region and along the leading edge, the blade is assumed to be fully stressed and undergoes large deflection. A specified portion of the blade around the impact region is modeled. The effect of ice size and velocity on the average leading edge strain are investigated for a modified SR-2 model unswept composite propfan blade. Parametric studies are performed to study the response due to ice impact at various locations along the span. Also, the effects of engine speed on the strain and impact displacements are discussed. It is found that for a given engine speed, a critical ice speed exists that corresponds to the maximum strain and this critical speed increases with increase in the engine speed. Author

N95-28343* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXPERIMENTAL INVESTIGATION OF INLET-COMBUSTOR ISOLATORS FOR A DUAL-MODE SCRAMJET AT A MACH NUMBER OF 4

SAIED EMAMI (Lockheed Engineering and Sciences Co., Hampton, VA.), CARL A. TREXLER, AARON H. AUSLENDER (Lockheed Engineering and Sciences Co., Hampton, VA.), and JOHN P. WEIDNER May 1995 93 p
(Contract(s)/Grant(s): RTOP 505-70-62-01)
(NASA-TP-3502; L-17422; NAS 1.60:3502) Avail: CASI HC A05/MF A01

This report details experimentally derived operational characteristics of numerous two-dimensional planar inlet-combustor isolator configurations at a Mach number of 4. Variations in geometry included (1) inlet cowl length; (2) inlet cowl rotation angle; (3) isolator length; and (4) utilization of a rearward-facing isolator step. To obtain inlet-isolator maximum pressure-rise data relevant to ramjet-engine combustion operation, configurations were mechanically back pressured. Results demonstrated that the combined inlet-isolator maximum back-pressure capability increases as a function of isolator length and contraction ratio, and that the initiation of unstart is nearly independent of inlet cowl length, inlet cowl contraction ratio, and mass capture. Additionally, data are presented quantifying the initiation of inlet unstarts and the corresponding unstart pressure levels. Author

N95-28344* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NUMERICAL ANALYSIS OF INTRA-CAVITY AND POWER-STREAM FLOW INTERACTION IN MULTIPLE GAS-TURBINE DISK-CAVITIES

M. M. ATHAVALE (CFD Research Corp., Huntsville, AL.), A. J. PRZEKAS (CFD Research Corp., Huntsville, AL.), R. C. HENDRICKS, and B. M. STEINETZ May 1995 19 p Presented at the Turbo Expo 1995, Houston, TX, 5-8 Jun. 1995; sponsored by ASME

(Contract(s)/Grant(s): RTOP 242-50-01)

(NASA-TM-106886; E-9523; NAS 1.15:106886) Avail: CASI HC A03/MF A01

A numerical analysis methodology and solutions of the interaction between the power stream and multiply-connected multi-cavity sealed secondary flow fields are presented. Flow solutions for a multi-cavity experimental rig were computed and compared with experimental data of Daniels and Johnson. The flow solutions illustrate the complex coupling between the main-path and the cavity flows as well as outline the flow thread that exists throughout the subplatform multiple cavities and seals. The analysis also shows that the decoupled solutions on single cavities is inadequate. The present results show trends similar to the T-700 engine data that suggests the changes in the CDP seal altered the flow fields throughout the engine and affected the engine performance. Author

N95-28646 Ceramic Composites, Inc., Millersville, MD.
CERAMIC COMPOSITE COMBUSTOR CANS FOR EXPENDABLE TURBINE ENGINES Final Report, 29 Apr. 1993 - 15 Feb. 1994

LARRY L. FEHRENBACHER and JOHN A. HANIGOSKY Mar. 1994 35 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): F33615-93-C-2321)
(AD-A289551; WL-TR-95-2001) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Ceramic matrix composite fabrication by microwave assisted chemical vapor infiltration (MWCVI) has been demonstrated as a feasible, faster, and more economical technique as compared to conventional CVI. Two deposition systems, carbon and silicon carbide, were investigated using this processing technique. Densification rates over an order of magnitude higher have been achieved on small cylindrical Nicalon fiber preforms. Economic forecasts based on previous SiC deposition and this Phase 1 work shows a significant improvement in part cost as compared to conventional CVI work. A reduction in cost of a factor of 20 has been calculated. A larger, commercial microwave system has been designed for scaled up prototype part fabrication. DTIC

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A95-82333
NUMERICAL ANALYSIS OF FLOW FIELD AROUND GAS RUDDER

LIBIN MA Northwestern Polytechnical University, Xi'an, Shanxi, China and HONGQING HE Northwestern Polytechnical University, Xi'an, Shanxi, China In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 259-264

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A two-dimensional flow field around a cross section of gas rudder along the gas flow direction is calculated. In calculation, the flow field around a cross section of gas rudder is divided into three

regions. Region 1 is the subsonic-transonic region behind curved shock wave around blunt-nosed body. Region 2 is the supersonic region behind curved shock wave. Region 3 is the supersonic flow region behind expansion wave. For these three flow regions, we adopt the strip-band method, characteristic method and Prandtl-Meyer formula, respectively, to calculate flow parameters.

Author (Herner)

A95-83000

ROBUST LONGITUDINAL AXIS FLIGHT CONTROL FOR AN AIRCRAFT WITH THRUST VECTORING

JAMES M. BUFFINGTON Control Analysis Section, Wright-Patterson, OH, United States, ANDREW G. SPARKS, and SIVA S. BANDA Automatica (ISSN 0005-1098) 30, 10 October 1994 p. 1527-1540 refs

(BTN-95-EIX95122538875) Copyright

A full conventional envelope longitudinal axis control design is presented for a fighter aircraft capable of thrust vectoring. An inner-loop modular control structure is used to provide good flying quantities in the presence of highly structured uncertainty across a wide flight envelope. Simple, low-order control laws are designed for a version of an F-18 aircraft model augmented with thrust vectoring nozzles. A minimal-order $H(\infty)$ design algorithm is used to aid in the design of an inner loop equalization controller. Structured singular value synthesis is used to design outer loop implicit model-following controllers. Different control laws are found for high and low dynamic pressure conditions, and controller commands are blended for a small region of dynamic pressure. Daisy-chaining is used to blend elevator and thrust vectoring commands. Structured singular values are used to analyze stability robustness to structured parametric uncertainty, actuator and sensor unmodeled dynamics, and structured uncertainty corresponding to controller blending. A nonlinear simulation is used to show that the aircraft performs well across the flight envelope during outer loop controller blending and thrust vectoring actuation.

Author (EI)

A95-83491

NONLINEAR DECOUPLING CONTROL STUDY FOR AIRCRAFT MANEUVERING FLIGHT

LI-XIN WANG Beijing Univ. of Aeronautics and Astronautics, Beijing, China and ZHAO-FENG HU Beijing Univ. of Aeronautics and Astronautics, Beijing, China Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 6, no. 3 August 1993 p. 170-177

(HTN-95-71130) Copyright

Based on the 12-state nonlinear aircraft dynamic model, a nonlinear decoupling control law which contains command static error integral loop is designed by combining nonlinear inverse dynamics theory and modern optimal control theory. This control law could minimize the performance index which contains the weighted state variables, control variables and their varying rates. Using this control law, the aircraft could capture the desired flight state more accurately and decouple the motions more completely with smooth control responses and less control energy. As the control law more accurately represents the nonlinear factors that arise in aircraft dynamic model and remedies the degrading of aircraft nonlinear dynamical behavior during maneuvering flight, it offers the potential for providing high levels of handling quality and flight performance in the entire flight envelope of the aircraft.

Author (Herner)

A95-85481

TRANSONIC FLUTTER SUPPRESSION USING ACTIVE ACOUSTIC EXCITATIONS

PONG-JEU LU Natl Cheng Kung Univ, Tainan, Taiwan, Province of China, DARTZI PAN, and DUN-YANN YEH AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 694-702 refs

(BTN-95-EIX95262694310) Copyright

The objective is to study the feasibility of using acoustic waves as a means for suppressing the flutter instability of a typical section in transonic flow. A high-resolution upwind TVD flow solver of

acoustic accuracy was first constructed and validated on a dynamic mesh system. The geometric conservation law was implemented consistently with the physical conservation law via a suitably defined cell boundary speed. This specially developed structure/fluid/acoustic solver was then integrated in the time domain to study whether flutter can be suppressed using active acoustic excitations. Flutter suppression was achieved in the transonic region when an appropriate feedback control law was used. Large-amplitude limit cycle type oscillation in a transonic flow was also simulated. It was found that the present acoustic control technique can only be effective when the amplitude of the oscillation is small in accordance with previous findings obtained in a low-speed wind-tunnel test.

Author (EI)

A95-86169

ACTIVE PLATE AND MISSILE WING DEVELOPMENT USING DIRECTIONALLY ATTACHED PIEZOELECTRIC ELEMENTS

RON BARRETT University of Kansas, Lawrence, KS, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 601-609

(HTN-95-42340) Copyright

The properties of directionally attached piezoelectric (DAP) elements and a low aspect ratio DAP torque-plate wing are investigated. Tests show that isotropic piezocentric elements exhibit orthotropic behavior when directionally attached using any of three methods: (1) partial attachment, (2) transverse shear lag, and (3) differential stiffness bonding. Closed-form expressions of DAP strains based on laminated plate theory are presented. The models demonstrate that DAP elements can generate pure extension, bending, or twist deflections in beams and plates. Activation sequences and balancing strains for DAP and conventionally attached piezoelectric (CAP) elements based on laminated plate theory are presented. Experimental beam specimens were constructed to verify the models. Tests show that 0.030-in. (0.0762-cm) thick aluminum beams with antisymmetrically laminated DAP elements produce twist rates of 0.23 deg/in. (9 deg/m) and bending rates in excess of 0.36 deg/in. (14 deg/m) with theory and experiment in close agreement. A DAP torque-plate was constructed of 8.0-mil-thick piezoceramic elements bonded antisymmetrically on a 5-mil steel substrate. The torque plate was then used to induce pitch deflections in a subsonic missile fin with a NACA 0012 profile and an aspect ratio of 1.4. The wing demonstrated a break frequency in excess of 80 Hz and static pitch deflections of 8.5 deg, showing excellent correlation with theory.

Author (Herner)

N95-26555 Naval Postgraduate School, Monterey, CA.

DESIGN AND SYNTHESIS OF A REAL-TIME CONTROLLER FOR AN UNMANNED AIR VEHICLE M.S. Thesis

PETER M. HOFFMAN Sep. 1994 121 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(AD-A289134) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The Naval Postgraduate School is developing a vertical take-off and landing (VTOL) unmanned air vehicle (UAV) that can transition to horizontal flight, once airborne, in order to take advantage of the improvements in speed, range, and loiter time that horizontal, fixed-wing flight provides. This research investigates the design requirements of the central controlling device for that UAV, including the specific problems of defining the necessary hardware components and developing software for executive control. First, hardware requirements needed to be determined. By exploring the general operational requirements of the UAV and taking into account space and weight limitations, a hardware suite was selected which could provide adequate functionality to replace the human traits of a pilot. In order to provide 'awareness' of the operational environment, motion sensors, navigation equipment, and communication equipment was required. Controllable servo-motors were necessary to move control surfaces appropriately. Computer hardware, necessary to provide system intelligence, was selected in order to interoperate with the other hardware. Next, a Real-Time Executive (RTE) software program was designed to provide the functionality and

coordination of all hardware components. Device drivers for each component were developed, and overall coordination was planned using a Yourdon style essential model. Periodic interrupts were used to control execution time. Last, the specifications and configuration of all hardware components were completely documented, and the operation of the RTE program fully explained. From this understanding of the overall control system, future development can continue, resulting in a more effective and efficient UAV design. DTIC

N95-26773* Army Aviation Systems Command, Moffett Field, CA. Aeroflightdynamics Directorate.

AN INVESTIGATION OF THE EFFECTS OF PITCH-ROLL (DE)COUPLING ON HELICOPTER HANDLING QUALITIES

C. L. BLANKEN (National Aeronautics and Space Administration, Ames Research Center, Moffett Field, CA.), H. J. PAUSDER (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany.), and C. J. OCKIER (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany.) May 1995 120 p (Contract(s)/Grant(s): RTOP 505-59-36) (NASA-TM-110349; A-950055; NAS 1.15:110349; USAATCOM-TR-95-A-003) Avail: CASI HC A06/MF A02

An extensive investigation of the effects of pitch-roll coupling on helicopter handling qualities was performed by the U.S. Army and Deutsche Forschungsanstalt fuer Luft- und Raumfahrt (DLR), using a NASA ground-based and a DLR in-flight simulator. Over 90 different coupling configurations were evaluated using a high gain roll-axis tracking task. The results show that although the current ADS-33C coupling criterion discriminates against those types of coupling typical of conventionally controlled helicopters, it is not always suited for the prediction of handling qualities of helicopters with modern control systems. Based on the observation that high frequency inputs during tracking are used to alleviate coupling, a frequency domain pitch-roll coupling criterion that uses the average coupling ratio between the bandwidth and neutral stability frequency is formulated. This criterion provides a more comprehensive coverage with respect to the different types of coupling, shows excellent consistency, and has the additional benefit that compliance testing data are obtained from the bandwidth/phase delay tests, so that no additional flight testing is needed. Author

N95-26949* Kansas Univ., Lawrence, KS.

AN EASY WAY TO ANALYZE LONGITUDINAL AND LATERAL-DIRECTIONAL TRIM PROBLEMS WITH AEO OR OEI

JAN ROSKAM and WILLIAM ANEMAAT (Design, Analysis and Research Corp., Lawrence, KS.) In Wichita State Univ., AIAA Techfest 20 Proceedings 22 p 1994 Avail: CASI HC A03/MF A03

Analyzing longitudinal and lateral-directional trim problems of airplanes with all-engines-operating (AEO) and with one-engine-inoperative (OEI) requires the solution of two sets of simultaneous equations. For longitudinal trim the set includes drag, lift, pitching moment, and elevator wheel force equations. For lateral-directional trim the set includes side-force, rolling moment, yawing moment, rudder pedal force, and aileron wheel force equations. Both sets of equations are non-linear; the process of finding a solution is therefore an iterative process. Solutions are very much dependent on the detailed aerodynamic design of the airplane, on the center of gravity location, and on various characteristics of the flight control system. The equations have been programmed as part of the user-friendly Advanced Aircraft Analysis (AAA) program. The purpose of the paper is to discuss several examples of how the stability and control engineer can use this aspect of the AAA program to rapidly resolve issues of control force levels, control force gradients, and flight path stability with AEO and OEI. Derived from text

N95-26957 Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

ELECTRO-HYDROSTATIC ACTUATOR CONTROLLER DESIGN USING QUANTITATIVE FEEDBACK THEORY M.S.

Thesis

KI HO KANG Dec. 1994 111 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289220; AFIT/GE/ENG/94D-18) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The Electro-Hydrostatic Actuator (EHA) technology offers a higher degree of combat survivability and easier maintainability of the aircraft flight control system, because all the components necessary to operate the actuator are collocated with the actuator. Quantitative Feedback Theory (QFT) is used to design a control system for the EHA. The impact of parameter variations, sensor noise, and flight conditions are explicitly considered in the design process. The solution utilizes a two loop QFT feedback structure. The inner loop structure stabilizes the motor's angular velocity and decreases the outer loop's uncertainty. The outer loop structure controls the RAM piston's position to track the input command. The resulting design is not only robust with respect to plant parameter variations, but is also insensitive to the effects of sensor noise. The actuator's phase lag is reduced by incorporating phase constraints in the QFT design paradigm. QFT is shown to be a viable tool in solving a real-world problem. DTIC

N95-26958 Air Force Inst. of Tech., Wright-Patterson AFB, OH. **A QUANTITATIVE FEEDBACK THEORY FCS DESIGN FOR THE SUBSONIC ENVELOPE OF THE VISTA F-16 INCLUDING CONFIGURATION VARIATION M.S. Thesis**

SCOTT N. PHILLIPS Dec. 1994 170 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289221; AFIT/GE/ENG/94D-24) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

An aircraft's response to control inputs varies widely throughout its flight envelope. The aircraft configuration also impacts control response through variations in center of gravity and moments of inertia. Designing a flight control system (FCS) to accommodate the full flight envelope and configuration set of an aircraft is clearly a complex undertaking. Quantitative feedback theory (QFT) is a design tool which enables the engineer to attack this task in an efficient way. Although QFT is a robust control design technique, it is an interactive algorithm allowing the engineer full control over compensator order and gain. In this research effort, a full subsonic flight envelope FCS is designed for the VISTA F-16 aircraft using QFT. Four aircraft configurations are considered. The strict control of the compensator order and gain allowed by QFT facilitates the attainment of desired performance while avoiding physical saturations. In addition, flying qualities are imbedded in the longitudinal design through the use of a control parameter which varies with the aircraft's energy state. This parameter is synthesized to closely reflect the actual control desires of the pilot throughout the aircraft flight envelope. Linear simulations with realistically large control inputs are used to validate the design. DTIC

N95-26981 Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

ADVANCED FORMATION FLIGHT CONTROL M.S. Thesis

MICHAEL J. VETH Dec. 1994 145 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289271; AFIT/GE/ENG/94D-30) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

In this thesis, the formation flight control problem is continued from four previous theses. Automatic formation flight involves controlling multiple aircraft equipped with standard Mach-hold, altitude hold, and heading-hold autopilots to maintain a desired distance from a lead aircraft or 'rabbit'. Changes in the rabbit's states are treated as disturbances to the system and rejected. Previous research is advanced in the following areas: Higher-order aircraft/autopilot models are included into the design and a new feedback control law is employed, resulting in more accurate simulations. An energy tracking scheme is developed and is shown to reduce wing aircraft energy excursions. Finally, the formation hold autopilot is modified to allow the wing aircraft to orbit a stationary reference point

08 AIRCRAFT STABILITY AND CONTROL

on the earth at a desired range, airspeed, and altitude. The importance of the disturbance rejection capability of the controller is demonstrated through comparisons of linearized model predictions with nonlinear simulations. The design tradeoffs between performance and robustness are emphasized. DTIC

N95-27036 Air Force Inst. of Tech., Wright-Patterson AFB, OH. **FLIGHT CONTROL DESIGN USING MIXED H2/MICRON OPTIMIZATION M.S. Thesis**
DOUGLAS D. DECKER Dec. 1994 159 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A289288; AFIT/GA/ENY/94D-8) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This thesis examines the use of the mixed H2/Microns optimal control synthesis method in the design of a flight control system for the lateral/directional axes of the F-16 Variable Stability In-Flight Simulator Test Aircraft (VISTA). The method is designed to minimize the H2 norm (two-norm) for a given value of microns. This should provide adequate noise and disturbance rejection while maintaining robustness against several types of uncertainties in the system. This thesis finds that, for this problem, the two-norm is not an accurate representation of the outputs of interest. When the two-norm is broken up into its constituent parts an appropriate solution can be found. This thesis also finds that it is possible to use an H2 controller which is destabilizing to the evaluation model as the starting point in the mixed H2/IL curve and still get an acceptable answer. A numerical approach was used, utilizing a recently improved computer algorithm. DTIC

N95-27839* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MODELING OF AIRCRAFT UNSTEADY AERODYNAMIC CHARACTERISTICS. PART 2: PARAMETERS ESTIMATED FROM WIND TUNNEL DATA
VLADISLAV KLEIN (Joint Inst. for Advancement of Flight Sciences, Hampton, VA.) and KEITH D. NODERER (Joint Inst. for Advancement of Flight Sciences, Hampton, VA.) Apr. 1995 43 p
(Contract(s)/Grant(s): RTOP 505-64-52-01)
(NASA-TM-110161; NAS 1.15:110161) Avail: CASI HC A03/MF A01

Aerodynamic equations with unsteady effects were formulated for an aircraft in one-degree-of-freedom, small-amplitude, harmonic motion. These equations were used as a model for aerodynamic parameter estimation from wind tunnel oscillatory data. The estimation algorithm was based on nonlinear least squares and was applied in three examples to the oscillatory data in pitch and roll of 70 deg triangular wing and an X-31 model, and in-sideslip oscillatory data of the High Incidence Research Model 2 (HIRM 2). All three examples indicated that a model using a simple indicial function can explain unsteady effects observed in measured data. The accuracy of the estimated parameters and model verification were strongly influenced by the number of data points with respect to the number of unknown parameters. Author

N95-28281* Naval Weapons Center, China Lake, CA.
COMPOSITE FLIGHT-CONTROL ACTUATOR DEVELOPMENT
RICHARD BOTT and FRED CHING (Textron, Inc., Valencia, CA.)
In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 3 p 1389-1404 Sep. 1992
(Contract(s)/Grant(s): N60530-88-C-0260)
Copyright Avail: CASI HC A03/MF A04

The composite actuator is 'jam resistant', satisfying a survivability requirement for the Navy. Typically, the push-pull force needed to drive through the wound area of the composite actuator is 73 percent less than that of an all-metal actuator. In addition to improving the aircraft's combat survivability, significant weight savings were realized. The current design of the survivable, composite actuator cylinder is 36 percent lighter than that of the production

steel cylinder, which equates to a 15 percent overall actuator weight savings. Author

N95-28598 Air Force Inst. of Tech., Wright-Patterson AFB, OH.
DEVELOPMENT OF A TECS CONTROL-LAW FOR THE LATERAL DIRECTIONAL AXIS OF THE MCDONNELL DOUGLAS F-15 EAGLE M.S. Thesis
MICHAEL A. BRUZZINI Dec. 1994 114 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A289771; AFIT/CI/CIA/94-159) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The purpose of this report is to develop automatic aircraft flight control systems using the concept of Total Energy Control System (TECS) in the lateral directional axis for the McDonnell Douglas F-15 Eagle. Nonlinear simulation was originally developed from actual flight tests conducted by the U.S. Air Force and generated into a Fortran code. Lt James P. Dutton then took the flight data code and generated a SIMULINK file 10. Using the SIMULINK file a control law developed on the linearized model can then be tested on the nonlinear model. DTIC

09

RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A95-82319
DESIGN FEATURES OF THE NAL RAMJET ENGINE TEST FACILITY

HIROSHI MIYAJIMA Kakuda Research Center, Kakuda, Miyagi, Japan, TATSUO ARAI Kobe Steel, LTD., Takasago, Hyogo, Japan, and GARY J. HANUS Fluidyne Engineering Co., Minneapolis, MN, US *In* International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 155-161
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The ramjet engine test facility at the National Aerospace Laboratory of Japan (NAL) is a free jet type hypersonic wind tunnel in which ramjet and scramjet engines are to be tested. Simulated flight conditions are Mach 4 at 20 km altitude, Mach 6 at 25 km, and Mach 8 at 35 km. The facility nozzle exit dimension is 51 cm square. The facility has two vitiated air heaters, one for Mach 6 and the other for Mach 8 operation, in addition to a cored-brick type storage heater. The engine fuel conditions are room temperature and heated (up to 700 K) hydrogen gases or liquid hydrogen. The test cabin dimension is 3 m diameter by 4 m length. Thrust measuring system was designed to measure lift forces and pitching moment as well as axial thrust and drag. This paper presents design characteristics of the facility and the mechanical design features of major wind tunnel components. Author (Herner)

A95-82320
HYPERSONIC WIND TUNNEL TEST OF SIDEWALL COMPRESSION TYPE SCRAMJET INLET

TAKESHI ITO Advanced Aircraft Research Group, Osawa, Mitaka, Japan, HIROSHI TANEDA Nagoya Aerospace Systems, Minato, Nagoya, Japan, KOUICHI HOZUMI National Aerospace Laboratory, Chofu, Tokyo, Japan, and AKIRA YOSHIZAWA National Aerospace Laboratory, Chofu, Tokyo, Japan *In* International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 163-168
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A Scramjet inlet model was tested in National Aerospace Laboratory's (NAL's) hypersonic wind tunnel at Mach 7.1. The inlet was side wall compression type with a foreplate. Its contraction ratio, sweep angle and the Mach number of the inlet entrance were set in

variable manner along the experimental plan. The changes of the flow pattern were caused by these parameters, and the basic performance of the inlet was investigated with the flow visualization and pressure measurement techniques. As a result, it was shown that the pressure near the foreplate increased at the higher contraction ratio or the lower Mach number of the inlet entrance, while the pressure near the cowl increased at the higher sweep angle of the inlet. The pressure distribution at the throat of the inlet became uniform and the highest pressure recovery was obtained, under the condition of the entrance Mach number 5.82, the contraction ratio 9.3 and the sweep angle 45 degree. Author (Hemer)

A95-85477

WIND-TUNNEL TESTS OF AN INCLINED CYLINDER HAVING HELICAL GROOVES

THOMAS D. STUART United States Navy, Arlington, VA, United States, JAMES M. CLIFTON, and LOUIS V. SCHMIDT AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 665-670 refs
(BTN-95-EIX95262694306) Copyright

A series of low-speed wind-tunnel investigations were conducted to determine the aerodynamic behavior of a helically grooved inclined cylinder representing a long trailing wire antenna towed from an orbiting aircraft. The large test angle of attack range of the wire required two model configurations. For higher angles of attack, full-scale wires were tested. For lower angles of attack, a 15-scale grooved, cylindrical model with an ogive nose was tested. Data were evaluated and empirical relationships for the normal and axial force coefficients were verified by comparison with historical references for the baseline clean circular cylinders and were extended for the grooved configurations. The existence of a side force coefficient due to circulation caused by the helical grooves was discovered, expressed analytically, and verified with flow-visualization techniques. The experimental coefficients were used to improve an existing digital simulation model describing the static-equilibrium conditions of a long cable towed by an aircraft. Inclusion of the side force influence in the static model proved consistent with flight-test observations of the wire's lateral skew angle and direction.

Author (EI)

N95-26378 Defence Science and Technology Organisation, Melbourne (Australia). Aeronautical and Maritime Research Lab. DESIGN AND DEVELOPMENT OF A TEST RIG FOR THE HIGH FREQUENCY TESTING OF ROLLING SLEEVE AIRSPRINGS

G. SWANTON Feb. 1995 32 p Original contains color illustrations (DSTO-TN-0001; AR-009-201) Copyright Avail: Issuing Activity AMRL's F/A-18 IFOSTP fatigue test has introduced several new concepts in the field of aircraft structural testing. One of the innovations has been the development of the pneumatic actuator or 'rolling sleeve' airspring for the application of aircraft maneuver loads. These airsprings have been subjected to several preliminary acceptance test phases, one of which simulated the effects of high frequency buffet loads. This report details the design and implementation of the test rig developed to conduct this type of testing.

Author

N95-26556 Institute for Defense Analyses, Alexandria, VA. THE VALUE OF SIMULATION FOR TRAINING Final Report, Sep. 1993 - Apr. 1994

JESSE ORLANSKY, CARL J. DAHLMAN, COLIN P. HAMMON, JOHN METZKO, HENRY L. TAYLOR, and CHRISTINE YOUNGBLUT Sep. 1994 173 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289174; IDA-P-2982; IDA/HQ-94-45529; SBI-AD-E501-856) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

All types of simulation are considered: (1) stand-alone; (2) networked interactive simulation; (3) live exercises; and (4) combat models. The utility of simulation is examined for individual and collective training conducted at institutions and in operational units. Cost data are reported on individual training at schools, training

technology, collective training in units, operating tempo, and procurement of simulation. Simulators used for flight training and maintenance training are cost-effective, compared to the use of actual equipment; the same is true for computer-based instruction. The acceptance and use of simulators depends heavily on the existence of adequate training programs, adequate performance feed-back, ability to replicate actual operating conditions, and user acceptance by unit commanders. Distributed interactive simulation is expected to make a major improvement in collective and joint training but it is too early to assess its utility. Suggestions are made with regard to the development of cost data needed for establishing policy on the use of simulation for training as well as for the support of technology needed to improve collective and joint training and joint readiness. DTIC

N95-26768*# Old Dominion Univ., Norfolk, VA. Dept. of Aerospace Engineering.

EXTENSION TO THE DYNAMIC MODELING OF THE LARGE ANGLE MAGNETIC SUSPENSION TEST FIXTURE M.S.

Thesis - Old Dominion Univ., May 1995 Progress Report, 1 Nov. 1994 - 30 Apr. 1995

LUCAS E. FOSTER and COLIN P. BRITCHER May 1995 133 p (Contract(s)/Grant(s): NAG1-1056) (NASA-CR-197801; NAS 1.26:197801) Avail: CASI HC A07/MF A02

The Large Angle Magnetic Suspension Test Fixture (LAMSTF) is a laboratory scale proof-of-concept system. The configuration is unique in that the electromagnets are mounted in a circular planar array. A mathematical model of the system had previously been developed, but was shown to have inaccuracies. These inaccuracies showed up in the step responses. Eddy currents were found to be the major cause of the modeling errors. In the original system, eddy currents existed in the aluminum baseplate, iron cores, and the sensor support frame. An attempt to include the eddy current dynamics in the system model is presented. The dynamics of a dummy sensor ring were added to the system. Adding the eddy current dynamics to the simulation improves the way it compares to the actual experiment. Also presented is a new method of determining the yaw angle of the suspended element. From the coil currents the yaw angle can be determined and the controller can be updated to suspend at the new current. This method has been used to demonstrate a 360 degree yaw angle rotation. Author

N95-26775*# MCAT Inst., San Jose, CA. COMPUTATIONAL SUPPORT OF THE LAMINAR FLOW SUPERSONIC WIND TUNNEL, CNSFV CODE DEVELOPMENT, MAGLEV, AND GRID GENERATION Final Report, 1 Jun. 1989 - 31 Jan. 1995

GOETZ H. KLOPFER 31 Jan. 1995 84 p Original contains color illustrations (Contract(s)/Grant(s): NCC2-616) (NASA-CR-197750; NAS 1.26:197750; MCAT-05-06) Avail: CASI HC A05/MF A01; 10 functional color pages

This final report covers the work done on corporate agreement NCC2-616 over a period of 5 1/2 years. It is broken into three segments of approximately 1 1/2 to 2 years each. The report is a summary report and is not intended to be comprehensive of all the work done under this corporate agreement. A more complete coverage of the work done is obtained from the papers and reports listed in the 'Papers' section. Additional reporting of significant work was done through 'Technical Highlights' and 'Research and Technical Summaries'. A listing of copies are given in the 'Technical Highlights and R and T' section. The work was also reported in a series of seminars, conference meetings, branch reviews, workshops, and project reviews. A list of these talks is given in the 'Presentation' section. Also during this time three students ranging from high school to graduate level were supervised. A list of the students and the type of work accomplished is given in the 'Mentoring' section. The report concludes with the 'Appendices' sections which include the three papers produced during the last 1 1/2 years of this corporate agreement. Author

09 RESEARCH AND SUPPORT FACILITIES (AIR)

N95-26837 Polish Academy of Sciences, Warsaw (Poland). Acoustic Metrology Lab.

PHOTOACOUSTIC CHAMBERS FOR STUDYING SOLIDS AND GASES: THEORY AND PRACTICAL EXAMPLES
[KOMORY FOTOAKUSTYCZNE DO BADANIA CIAŁ STALYCH I GAZÓW: TEORIA I PROZYKLADY ROZWIĄZAŃ]
JERZY MOTYLEWSKI and TOMASZ ZMIERCZAK 1994 34 p In POLISH

(ISSN 0208-5658)

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In this article the authors describe examples of theoretical models of the operation of photoacoustic chambers designed to operate in photoacoustic spectroscopic systems used to analyze the physical and chemical properties of solids and gases by means of photoacoustic spectroscopy (PAS). In particular, the theoretical analysis covers the effect of the chamber's dimensions, the analyzed sample, and the modulation of the exciting light on the amplitude of the photoacoustic signal and the ways in which energy losses in the photoacoustic detector are accounted for. The authors note the possibility of reducing the effect of penetrating acoustic noise in chambers used to analyze the properties of gases by using acoustic filters. The authors describe examples of photoacoustic chambers designed to analyze solids and gases.

Transl. by SCITRAN

N95-26944# Lear Jet Industries, Inc., Wichita, KS.
AIRCRAFT NOSEWHEEL STEERING SIMULATION Abstract Only

WAYNE STOUT In Wichita State Univ., AIAA Techfest 20 Proceedings 48 p 1994

Avail: CASI HC A03/MF A03

This paper reports the simulation of aircraft nosewheel steering and it has the following objectives: demonstrate power and effectiveness of simulation tools, highlight modular (subsystem) buildup of complex simulation model, show complexity of suspension/steering dynamics, and highlight characteristics of pilot when performing nosewheel steering task.

CASI

N95-26951# Kansas Univ., Lawrence, KS.
PRELIMINARY RESULTS AND RESEARCH CAPABILITIES OF A NEW JET FACILITY AT THE UNIVERSITY OF KANSAS
JASON FRANK, TOM SHERWOOD, and RAY TAGHAVI In Wichita State Univ., AIAA Techfest 20 Proceedings 16 p 1994

Avail: CASI HC A03/MF A03

The recently completed free jet facility at the University of Kansas was designed to be versatile in research capabilities. The free-shear flow testing apparatus operates in both subsonic and supersonic regimes to test jet exhaust nozzles, diffusers, and combustor geometries with and without swirl. Currently proposed areas of research have application in engine exhaust design, jet diffusion, and supersonic jet noise research. The equipment is comprised of a plenum tank, flow conditioners, bellmouth, and adapter and various subsonic and supersonic nozzle attachments. A jet engine starting unit provides enough flow to choke a 3.5 inch diameter nozzle. Flow field variables can be measured with pitot tubes and hot-wire anemometry, as well as with laser Doppler velocimetry. Preliminary data indicate a top hat exit velocity profile with less than 1% core turbulence intensity.

Author

N95-26966 Air Force Inst. of Tech., Wright-Patterson AFB, OH.
AN INVESTIGATION OF THE AFIT 2-INCH SHOCK TUBE AS A FLOW SOURCE FOR SUPERSONIC TESTING M.S. Thesis
KEVIN M. VLCEK Dec. 1994 52 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289246; AFIT/GA/ENY/94D-1) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

An investigation of the AFIT high pressure shock tube was conducted to determine how closely it followed ideal shock tube theory and to determine the available test times for an attached Mach 3 nozzle. The driver section was five feet (1.52 m) long and the

driven section was 25 feet (7.62 m) long. The driver gas used for this study was helium while the driven gas was atmospheric air. The pressure rise measured behind the incident shock wave was, on average, 30% lower than predicted by the ideal shock tube relations. Behind the reflected shock, the pressure rise was 65% lower than predictions based on initial driver gas pressure. Due to supply pressure limits and lower than predicted pressures behind the shock waves, fully expanded flow in the Mach 3 nozzle was not attained. However, steady overexpanded flows of Mach 2.74-2.96 were observed for periods of 4-12 milliseconds.

DTIC

N95-27176*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NASA LEWIS RESEARCH CENTER'S COMBUSTOR TEST FACILITIES AND CAPABILITIES

JEAN BIANCO May 1995 13 p Presented at the 31st Joint Propulsion Conference and Exhibit, San Diego, CA, 10-12 Jul. 1995; cosponsored by AIAA, ASME, SAE, and ASEE

(Contract(s)/Grant(s): RTOP 505-62-82)

(NASA-TM-106903; E-9599; NAS 1.15:106903; AIAA PAPER 95-2681) Avail: CASI HC A03/MF A01

NASA Lewis Research Center (LeRC) presently accommodates a total of six combustor test facilities with unique capabilities. The facilities are used to evaluate combustor and afterburner concepts for future engine applications, and also to test the survivability and performance of innovative high temperature materials, new instrumentation, and engine components in a realistic jet engine environment. The facilities provide a variety of test section interfaces and lengths to allow for flametube, sector and component testing. The facilities can accommodate a wide range of operating conditions due to differing capabilities in the following areas: inlet air pressure, temperature, and flow; fuel flow rate, pressure, and fuel storage capacity; maximum combustion zone temperature; cooling water flow rate and pressure; types of exhaust - atmospheric or altitude; air heater supply pressure; and types of air heaters - vitiated or nonvitiated. All of the facilities have provisions for standard gas (emissions) analysis, and a few of the facilities are equipped with specialized gas analysis equipment, smoke and particle size measurement devices, and a variety of laser systems. This report will present some of the unique features of each of the high temperature/high pressure combustor test facilities at NASA LeRC.

Author

N95-28151 Federal Aviation Administration, Washington, DC. Office of Airport Planning and Programming.

ENPLANEMENT AND ALL CARGO ACTIVITY

Apr. 1994 153 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A280074; DOT/FAA/PP-94-1) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The Enplanement and All-Cargo Activity publication is a summary of enplanement data extracted from the Air Carrier Activity Information System (ACAIS). The ACAIS is a database which contains revenue passenger enplanement data and all-cargo landing data. The database supports the Federal Aviation Administration's Airport Improvement Program (AIP) entitlement activities.

Derived from text

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ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

A95-82324

EXPERIMENT OF ROCKET-RAM ANNULAR COMBUSTOR

N. YATSUYANAGI Kakuda Research Center, Miyagi, Japan, H.

SAKAMOTO Kakuda Research Center, Miyagi, Japan, K. SATO Kakuda Research Center, Miyagi, Japan, F. ONO Kakuda Research Center, Miyagi, Japan, M. SASAKI Kakuda Research Center, Miyagi, Japan, and M. TAKAHASHI Kakuda Research Center, Miyagi, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 189-195 Copyright*

In this experiment, the double-nozzle type of rocket-ram annular combustor with a total thrust of 5kN was designed and tested with varying ratios of thrust produced by rocket and ram. Thrust and pressure distribution along the common expansion nozzle, i.e., the ram combustor nozzle, were measured to investigate the effect of interaction of the two expansion gases on thrust. Enhancement of specific impulse was verified by the experiments. That is, the specific impulse gains in rocket-ram parallel operation, the ratio of rocket thrust to ram thrust being 50 to 50, were found to be 190 percent of gains in pure rocket operation. Author (Hemer)

A95-82355

R & D ON HOPE STRUCTURE

YOSHIKI MORINO National Space Development Agency of Japan, Tsukuba, Ibaraki, Japan, ATSUSHI MURAKAMI National Space Development Agency of Japan, Tsukuba, Ibaraki, Japan, and HIROBUMI TAMURA National Space Development Agency of Japan, Tsukuba, Ibaraki, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 409-414 Copyright*

This paper presents current status of research and development on the primary structure of the H-II Orbiting Plane (HOPE). Design requirements on the HOPE structure are presented and discussed together with the latest concept of the HOPE structure. Mechanical properties of graphite/polyimide composite, which is the first candidate material for the primary structure, are reported under expected flight environments of HOPE. Results of fabrication tests are also described. Mechanical properties of graphite/polyimide were evaluated, and the fabrication technique was examined. The end of life properties after being exposed to thermal cycles of aerodynamic heating and radiation in orbit, are favorable, and space environmental effects are not critical. And fabrication process and technique of critical parts and elements are confirmed. As a consequence of these results, we think graphite/polyimide can be applied to the HOPE structure, although fabrication development should be continued to obtain fabrication process related to the actual design of HOPE structural components. For high temperature regions such as the nose cone and leading edge, carbon-carbon composite materials will be used. We are now conducting material characterization tests and evaluating applicability of the materials. Up to the present, it is feasible to apply carbon-carbon to simple and low-load structures. Feasibility tests of the high load areas such as elevon and tip-fin will be performed in near future. Author (Hemer)

A95-82358

RESEARCH AND DEVELOPMENT OF THERMAL PROTECTION SYSTEM OF HOPE RE-ENTRY VEHICLE

YOICHI SATO Tsukuba Space Center, Tsukuba, Ibaraki, Japan, YOSHIKI MORINO Tsukuba Space Center, Tsukuba, Ibaraki, Japan, and TOMOYUKI KOBAYASHI Tsukuba Space Center, Tsukuba, Ibaraki, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 431-436 Copyright*

This paper presents the objectives and the current status of Research and Development of Thermal Protection System (TPS) for H-II Orbiting Plane (HOPE). Now, conceptual study of HOPE is in progress. In this phase, the National Space Development Agency of Japan (NASDA) has chosen three TPS concepts as the candidates for HOPE TPS, i.e. titanium multiwall (Ti/MW) TPS, carbon-carbon

(C/C) TPS, and ceramic tile TPS. The objectives of the conceptual study are trade-off study of those TPS concepts, development and evaluation of materials, and formulation of the development and verification programs. The objectives of the conceptual study of HOPE TPS are outlined, and the current status of design study and hardware developments is described. Author (Hemer)

A95-82384

HYPERSONIC TRAJECTORY CONTROL OF AEROSPACE PLANE WITH INTEGRATED SCRAMJET ENGINE

KOICHI YONEMOTO Kawasaki Heavy Industries, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 593-602 Copyright*

The aerospace plane is an airbreathing 'propulsion configured' vehicle having proper forebody contour for inflow pre-compression to the inlet and afterbody that operates as an external expansion nozzle. Since the whole lower side of the body acts as important compression and expansion elements for the airbreathing engine, the flight attitude influences its performance such as specific impulse and thrust coefficient considerably. The stability of ascent trajectory controlling dynamic pressure or heat-input rate is analyzed considering the performance change due to attitude fluctuation. The performance of scramjet engine, a typical hypersonic airbreathing engine, is estimated by a rapid prediction methodology of the combustor proposed by Ikawa. Author (Hemer)

A95-82400

VSL ANALYSIS OF HYPERSONIC FLOWS AROUND A REENTRY VEHICLE WITH EQUILIBRIUM AIR CHEMISTRY

YOSHITAKA SAKAMURA Kyushu University, Fukuoka, Japan and MICHIO NISHIDA Kyushu University, Fukuoka, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 697-702 Copyright*

In the present work, the viscous shock layer (VSL) equations coupled with a rapid code for the computation of equilibrium composition of air are numerically solved for the conditions of atmospheric entry at the altitudes of 40 km, 50 km, and 60 km, and then the effects of the flight altitude, the flight Mach number and the nose radius of a reentry body on the aerodynamic heating in equilibrium air flows are examined. The results show that the calculated wall temperature increases as the altitude becomes lower, and also increases almost linearly with the flight Mach numbers ($M_{\text{sub infinity}} = 15$ to 25). The wall heat flux at the stagnation point varies approximately with the inverse of the square root of the nose radius, and is essentially all convective, as predicted by the classic boundary layer analysis. Author (Hemer)

A95-82412

AIR DATA SENSORS FOR ATMOSPHERIC REENTRY FLIGHT TEST OF WINGED SPACE VEHICLE

YOSHIFUMI INATANI Institute of Space and Astronautical Science, Kanagawa, Japan and KOICHI YONEMOTO Kawasaki Heavy Industry, Gifu, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 773-780 Copyright*

The first atmospheric reentry flight of a winged space vehicle in Japan was conducted and an Air Data Sensor (ADS) System was developed for the flight test. ADS was designed to measure flight angle-of-attack and sideslip associated with the flight Mach number. These outputs from ADS were used for the flight control loop in real time, where the Mach number was used for control gain scheduling. After completion of the preliminary flight test using a sounding rocket, the reentry flight was carried out and ADS flight hardware worked as designed. ADS derived flight control was activated and completed the reentry transient. However, in the decelerating flight,

10 ASTRONAUTICS

primarily due to an error in the Mach number measurement and a preset timing of initiation of gain scheduling, the vehicle experienced an instability. The outcome of these studies and flight experiences are summarized.

Author (Hemer)

A95-82414

HYPERSONIC THERMAL PROTECTION WITH MASS INJECTION AT ANGLE OF ATTACK

SHIRO YAMAMOTO University of Tokyo, Tokyo, Japan, SHINICHI MATSUMOTO University of Tokyo, Tokyo, Japan, TADAHARU WATANUKI University of Tokyo, Tokyo, Japan, and HIROTOSHI KUBOTA University of Tokyo, Tokyo, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 787-792*
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Mass injection cooling is one of thermal protection methods against aerodynamic heating or other heating environments. It has some varieties. The film cooling method is one of them, and it has been investigated for a flat plate with a backward slot injection or for an axisymmetric body with mass injection at stagnation point. In this study, two injection modes are considered. One is a two-dimensional blunt body with mass injection in normal direction to the body surface (NIT). The other is a basically similar body with a step with mass injection in tangential direction along the body surface (TIT). Dominant parameters are angle of attack and ratio of the mass flow rate of the cooling air to that of free-stream. Adiabatic surface temperature distribution is used for evaluation of cooling effectiveness. For NIT, a wide region of the surface is cooled when angle of attack equals to zero, while the surface near the stagnation point cannot be cooled with non-zero angle of attack. For TIT, all of the surface can be cooled at finite incidence except when very large or small.

Author (Hemer)

A95-82477

A CONCEPT OF A HYPERSONIC FLIGHT EXPERIMENT OF A WINGED VEHICLE

MASAO SHIROUZU National Aerospace Laboratory, Tokyo, Japan and SHIGEYA WATANABE National Aerospace Laboratory, Tokyo, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 1221-1226*
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A concept of a flight experiment using a winged hypersonic research vehicle is proposed by the National Aerospace Laboratory (NAL) as one of the flight experiment series preceding to the development of HOPE (H-II Orbiting Plane). The present paper describes the purpose of the experiment, the outline of the flight, the configuration and aerodynamic characteristics of the vehicle, and items of experiment and measurement. The present experiment is to acquire experience on the development and the flight of a hypersonic winged vehicle, in contrast to the ballistic flight of the OREX (Orbital Reentry Experiment) and to collect flight data for validation of tests and simulations on the ground. The vehicle of about 1.5 tons will be launched by a two-stage version of the J-I. The vehicle will be separated at an altitude of 70-80 km at a velocity of Mach 18-20, and inserted to the reentry trajectory of HOPE. The vehicle will be decelerated by parachutes and splash into the ocean south of Japan, where it will be recovered.

Author (Hemer)

A95-82483

ATMOSPHERIC REENTRY FLIGHT TEST OF WINGED SPACE VEHICLE

YOSHIFUMI INATANI Institute of Space and Astronautical Science, Kanagawa, Japan, RYOJIRO AKIBA Institute of Space and Astronautical Science, Kanagawa, Japan, MOTOKI HINADA Institute of Space and Astronautical Science, Kanagawa, Japan, and MAKOTO NAGATOMO Institute of Space and Astronautical Science, Kanagawa, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols*

1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 1263-1270

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A summary of the atmospheric reentry flight experiment of winged space vehicle is presented. The test was conducted and carried out by the Institute of Space and Astronautical Science (ISAS) in Feb. 1992 in Kagoshima Space Center. It is the first Japanese atmospheric reentry flight of the controlled lifting vehicle. A prime objective of the flight is to demonstrate a high speed atmospheric entry flight capability and high-angle-of-attack flight capability in terms of aerodynamics, flight dynamics and flight control of these kind of vehicles. The launch of the winged vehicle was made by balloon and solid propellant rocket booster which was also the first trial in Japan. The vehicle accomplishes the flight from space-equivalent condition to the atmospheric flight condition where reaction control system (RCS) attitude stabilization and aerodynamic control was used, respectively. In the flight, the vehicle's attitude was measured by both an inertial measurement unit (IMU) and an air data sensor (ADS) which were employed into an auto-pilot flight control loop. After completion of the entry transient flight, the vehicle experienced unexpected instability during the atmospheric decelerating flight; however, it recovered the attitude orientation and completed the transonic flight after that. The latest analysis shows that it is due to the ADS measurement error and the flight control gain scheduling; what happened was all understood. Some details of the test and the brief summary of the current status of the post flight analysis are presented.

Author (Hemer)

A95-82499

REENTRY TECHNOLOGY EXPERIMENT ON THE FIRST MISSION OF REENTRY CAPSULE 'EXPRESS'

TAKASHI ABE Institute of Space and Astronautical Science, Kanagawa, Japan, YOSHIFUMI INATANI Institute of Space and Astronautical Science, Kanagawa, Japan, KOJIRO SUZUKI Institute of Space and Astronautical Science, Kanagawa, Japan, MOTOKI HINADA Institute of Space and Astronautical Science, Kanagawa, Japan, MICHAEL BITZER Technical University of Braunschweig, Braunschweig, Germany, and HERBERT OERTEL Technical University of Braunschweig, Braunschweig, Germany *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 1383-1388*

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The flight experiment for the reentry technology was planned by using the reusable capsule type vehicle named as EXPRESS (EXPERIMENTAL REUsable Space System). The experiment includes the validation experiment for our knowledge of the hypersonic flow and the flight environmental test for the newly-developed heat shield system. The rationale and details for the experiment are presented.

Author (Hemer)

A95-82515

STUDY ON A SCHEME FOR THE PROLONGATION OF MICROGRAVITY TIME OF BALLOON-BORNE DROP CAPSULE

WANG LINHUA Space Science and Application Research Center, Beijing, China and LOU YUE Space Science and Application Research Center, Beijing, China *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 1485-1489*

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This paper discusses a scheme for the prolongation of the microgravity duration of balloon-borne drop capsule and presents the compensation system of aerodynamic drag and attitude control system of the drop capsule in order to perform such a scheme. A drop capsule equipped with the controllable cold gas thruster system will bring about a microgravity duration of 60 seconds at a gravity level less than $1 \times 10^{-6} \text{ g}$. In addition, the paper also briefly describes the recovery system of the drop capsule under the condition of high speed descent.

Author (Hemer)

A95-82553

HOW 'HITEN'S' AEROBRAKING EXPERIMENTS WERE CARRIED OUT

JUN'ICHIRO KAWAGUCHI Inst. of Space and Astronautical Science, Kanagawa, Japan, TAKASHI ABE Inst. of Space and Astronautical Science, Kanagawa, Japan, and KUNINORI UESUGI Inst. of Space and Astronautical Science, Kanagawa, Japan *In International Symposium on Space Technology and Science*, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 1735-1740 Copyright

The ISAS (Institute of Space and Astronautical Science) 'HITEN' spacecraft was launched in January of 1990 from Kagoshima Space Center. The major mission was to demonstrate the so-called Double Lunar Swing-by Orbit as a precursor of GEOTAIL that is one spacecraft among the ISTP (International Solar Terrestrial Physics Program) fleet and scheduled to be launched in July, 1992. It carried various kinds of engineering missions on board, among them aerobraking experiments. Aerobraking as well as aerocapture techniques have been of great concern in interplanetary explorations since they may save tremendous amount of fuel and add to scientific payload. However, practical application has not been made yet due to lack of aerothermodynamic features as well as guidance and navigation strategies. HITEN was specifically designed so that it could demonstrate and exemplify these aspects. It carried an anti-thermal blanket atop and two heat flux sensors to measure thermal environment during aerobraking. This paper presents how this world's first cis-lunar aerobraking experiment was carried out and what was found through it. Both heat flux and acceleration data obtained were well accounted for. Author (Herner)

A95-82554

AERO-THERMODYNAMIC FLIGHT ENVIRONMENT AT HITEN AEROBRAKE EXPERIMENT

TAKASHI ABE Inst. of Space and Astronautical Science, Kanagawa, Japan, JUN'ICHIRO KAWAGUCHI Inst. of Space and Astronautical Science, Kanagawa, Japan, and KUNINORI UESUGI Inst. of Space and Astronautical Science, Kanagawa, Japan *In International Symposium on Space Technology and Science*, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 1741-1746 Copyright

The aerothermodynamic flight environment of the HITEN aerobrake experiments was analyzed through comparison with the theoretical prediction and the measured data. Excellent agreement was obtained from the viewpoint of the aerodynamical flight environment. As for the thermodynamic flight environment, slight discrepancies remain to be resolved between the theoretical predictions and the flight data. The possible candidates for the cause of the discrepancies was clarified. Author (Herner)

A95-84884* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

OPTIMAL TRAJECTORIES FOR HYPERSONIC LAUNCH VEHICLES

MARK D. ARDEMA NASA. Ames Research Center, Moffett Field, CA, US, JEFFREY V. BOWLES NASA. Ames Research Center, Moffett Field, CA, US, and THOMAS WHITTAKER NASA. Ames Research Center, Moffett Field, CA, US *Dynamics and Control* (ISSN 0925-4668) vol. 4, no. 4 October 1994 p. 337-347 (HTN-95-61120) Copyright

In this paper, we derive a near-optimal guidance law for the ascent trajectory from earth surface to earth orbit of a hypersonic, dual-mode propulsion, lifting vehicle. Of interest are both the optimal flight path and the optimal operation of the propulsion system. The guidance law is developed from the energy-state approximation of the equations of motion. Because liquid hydrogen fueled hypersonic aircraft are volume sensitive, as well as weight sensitive, the cost functional is a weighted sum of fuel mass and volume; the weighting factor is chosen to minimize gross take-off weight for a given payload mass and volume in orbit. Author (Herner)

A95-85774* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

REENTRY ANALYSIS FOR LOW EARTH ORBITING SPACECRAFT

LAURI KRAFT NEWMAN NASA. Goddard Space Flight Center, Greenbelt, MD, US, DAVID C. FOLTA NASA. Goddard Space Flight Center, Greenbelt, MD, US, BRIAN P. ROSS NASA. Johnson Space Center, Houston, TX, US, and STANLEY A. BOUSLOG Lockheed Engineering and Sciences Co., Houston, TX, US *In Spaceflight dynamics 1993; AAS/NASA International Symposium*, 8th, Greenbelt, MD, Apr. 26-30, 1993, Parts 1 & 2. A95-85716 San Diego, CA American Astronautical Society (Advances in the Astronautical Sciences, Vol. 84, Pts. 1 & 2) (ISSN 0065-3438) 1993 p. 835-846 Copyright

As a result of recent National Aeronautics and Space Administration (NASA) Management Instruction (NMI), NASA spacecraft programs must limit orbital debris by design and/or by operational procedures. To fulfill this requirement, spacecraft may be required to be removed from their operational orbit after mission completion. Spacecraft disposal by atmospheric reentry is a means to accomplish this task. To assess the risk to man, an analysis must be done to determine which parts of the spacecraft are likely to survive a reentry of the Earth's atmosphere and where those parts will land. These issues are currently being examined for the Earth Observing System (EOS-AM1). The Johnson Space Center (JSC) Aeroscience Branch, supported by the Lockheed Engineering and Sciences Co., has developed a tool which permits the analysis of the thermal effects of reentry on individual spacecraft components to determine which components are expected to survive reentry. This paper presents an examination of the burnup and reentry of EOS-AM1 and describes a method for other spacecraft to use in analyzing similar reentry issues. Author (Herner)

A95-85807* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

THE EFFECT OF HIGH LIFT TO DRAG RATIO ON AEROBRAKING

PATRICK CROUSE NASA. Goddard Space Flight Center, Greenbelt, MD, US and MARK LEWIS Maryland Univ., College Park, MD, US *In Spaceflight dynamics 1993; AAS/NASA International Symposium*, 8th, Greenbelt, MD, Apr. 26-30, 1993, Parts 1 & 2. A95-85716 San Diego, CA American Astronautical Society (Advances in the Astronautical Sciences, Vol. 84, Pts. 1 & 2) (ISSN 0065-3438) 1993 p. 1265-1278 Copyright

This work reviews the use of aerodynamic forces to modify the velocity, and therefore, the orbital path of vehicles due to transit through planetary atmospheres, especially when high values of lift can be generated. The concepts of aerobraking and aerocapture are examined, and the limiting factors are discussed. The use of high L/D vehicles, such as hypersonic waveriders, is examined, and the advantages and disadvantages of their use for aerocapture are addressed. This preliminary study of non-optimized aerocapture trajectories suggests that entrance velocities at Mars can be 10 - 12 km/sec for a waverider while sustaining acceptable loads of about 3 - 4 Earth G's over a 3 minute period, diminishing to less than 1 G in about 15 minutes. The entrance velocities are greater than those for a more conventional biconic configuration with similar deceleration loads sustained. The convective heating rate on the waverider, increased due to the higher velocities and sharp leading edges, has an estimated upper bound of 14000 W/sq cm and a corresponding temperature of about 7500 degrees K. Author (Herner)

N95-27093*# Remtech, Inc., Huntsville, AL.

RAREFIED GAS EFFECTS ON AEROBRAKING/REENTRY VEHICLES WITH WAKES Final Report

AMOLAK C. JAIN 28 Feb. 1995 93 p (Contract(s)/Grant(s): NAS8-39368; SBIR-02.04-8581) (NASA-CR-196586; NAS 1.26:196586; RTR-249-01) Avail: CASI HC A05/MF A01

The purpose of the present investigation is to understand the

10 ASTRONAUTICS

basic nature of the wake flow behind an Aeroassisted Space Transfer Vehicle (ASTV) or Aeroassisted Flight Experiment Vehicle (AFE). The astronauts were supposed to fly in the bay of an ASTV or AFE. This problem of thermal environment on the bay of the vehicle becomes important to ensure the safety of the astronauts. A computer code based on the full Navier-Stokes equations with surface slip and temperature jump boundary conditions is developed. The governing equations are expressed in spherical-cylindrical coordinates and a third order accurate upwind-biased scheme with provision to use a second order accurate central-difference scheme of numerical integration, is used. To ensure a high order of accuracy, complete flowfield from the stagnation line to the wake flow is computed. For this purpose, the computer code is divided into three parts, viz., stagnation part, forepart and aftpart and has the provision to converge each part to provide boundary conditions to the next part or we can compute the entire flow in each iteration. Extensive numerical computations have been carried out for a number of prescribed conditions, but for the sake of brevity, the results of computations for SR3 tunnel conditions of CNRS, France, are reported here. Computations have been carried out on a cylindrical body with a spherical nose (also called sphere-cylinder body) and on a hemisphere with a cylindrical bay with radius equal to a quarter of the radius of the base of hemisphere, to simulate a generic AFE configuration. Comparison of the results on sphere-cylinder and on the generic AFE body helps us to understand the rarefaction effects and the effect of wake flow on the main flowfield. Comparison with the DSMC data from NASA LaRC indicates general agreement about the nature of wake, but our results differ quantitatively with the DSMC results. At the present moment, the results from the CNRS tunnel are not available. As such, a quantitative comparison of the present results with the experimental data is not possible. In general, it is found that the wake on a generic AFE is a slow moving, high temperature, low density and, consequently, low pressure fluid.

Author

N95-27434* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPARISON OF NUMERICAL RESULTS AND MULTICAVITY PURGE AND RIM SEAL DATA WITH EXTENSIONS TO DYNAMICS

MAHESH ATHAVALE (CFD Research Corp., Huntsville, AL.), ANDRZEJ J. PRZEKAS (CFD Research Corp., Huntsville, AL.), ROBERT C. HENDRICKS, and BRUCE M. STEINETZ May 1995 26 p Presented at the Third Northern Ohio Technical Symposium, Aerospace Today, Cleveland, OH, 16 May 1994; sponsored by the AIAA Original contains color illustrations (Contract(s)/Grant(s): RTOP 232-01-02) (NASA-TM-106685; E-9039; NAS 1.15:106685) Avail: CASI HC A03/MF A01; 6 functional color pages

The computation of flows within interconnected, multiple-disk cavities shows strong interaction between the cavities and the power stream. For this reason, simulations of single cavities in such cases are not realistic; the complete, linked configuration must be considered. Unsteady flow fields affect engine stability and can engender power-stream-driven secondary flows that produce local hot spotting or general cavity heating. Further, a concentric whirling rotor produces a circumferential pressure wave, but a statically eccentric whirling rotor produces a radial wave; both waves affect cavity ingestion and the stability of the entire engine. It is strongly suggested that seals be used to enhance turbojet engine stability. Simple devices, such as swirl brakes, honeycomb inserts, and new seal configurations, should be considered. The cost effectiveness of the NASA Lewis Research Center seals program can be expressed in terms of program goals (e.g., the Integrated High-pressure/Temperature Engine Technology (IHPTET) cannot be achieved without such a program), cost (savings to \$250 million/1-percent decrease in specific fuel consumption), and indirect benefits (reduction of atmospheric NO(x) and CO₂ and reduction of powerplant downtime).

Author

N95-27763* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

FLIGHT MECHANICS/ESTIMATION THEORY SYMPOSIUM 1995

KATHY R. HARTMAN, ed. May 1995 424 p Symposium held in Greenbelt, MD, 16-18 May 1995 (Contract(s)/Grant(s): RTOP 550-00-00) (NASA-CP-3299; REPT-95B00075; NAS 1.55:3299) Avail: CASI HC A18/MF A04

This conference publication includes 41 papers and abstracts presented at the Flight Mechanics/ Estimation Theory Symposium on May 16-18, 1995. Sponsored by the Flight Dynamics Division of Goddard Space Flight Center, this symposium featured technical papers on a wide range of issues related to orbit-attitude prediction, determination, and control; attitude sensor calibration; attitude determination error analysis; attitude dynamics; and orbit decay and maneuver strategy. Government, industry, and the academic community participated in the preparation and presentation of these papers. For individual titles, see N95-27764 through N95-27804.

11

CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A95-82301

IGNITION ANALYSIS OF HYDROGEN/AIR MIXTURE IN SUPERSONIC MIXING LAYER

YIGUANG JU Tohoku University, Katahira, Sendai, Japan and TAKASHI NIIOKA Tohoku University, Katahira, Sendai, Japan In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 7-12 Copyright

A unified analytical procedure is performed to analyze the problem of laminar mixing and ignition of a premixed gas coming into contact with a hot inert gas under going a chain mechanism, which consists of a second-order chain-branching reaction and a second-order chain-termination reaction. A comparison between the present analysis and the author's former one, which is obtained from the analysis of the radical concentration runaway, shows that two kinds of analyses agree well for not too slow chain-branching reaction and a better resolution of the ignition location is given by the present analysis for slow branching reaction. The solution is simplified to a simple ordinary differential equation, and the lower branch of the characteristic S-shaped curve corresponding to a nearly frozen ignition regime is produced by using the critical Damkohler numbers. Ignition location is investigated with special attention paid to the shear parameters and chemical kinetics. The results show that ignition depends strongly on the shear mixing and reaction rates. By employing the present analysis, the ignition location of hydrogen and air mixtures is calculated as an example of a reduced two-step mechanism.

Author (Herner)

A95-84201

CONTROL REQUIREMENTS FOR THE RB 211 LOW-EMISSION COMBUSTION SYSTEM

N. C. CORBETT Rolls-Royce Industrial & Marine Gas Turbines Ltd, Ansty, United Kingdom and N. P. LINES Journal of Engineering for Gas Turbines and Power, Transactions of the ASME (ISSN 0742-4795) vol. 116, no. 3 July 1994 p. 527-533 (BTN-94-EIX95011441244) Copyright

The RB 211 DLE series staged, premix, lean burn combustor demands total integration of control system and combustion hardware. The controls design process is described from the conception of the Engine Management System (EMS), which provides protec-

tion and control in separate environments, through to implementation of engine development testing. The process of devising an acceptable fueling strategy to each combustion stage is discussed. This identified the requirements for the computation of complex routines in order to control combustion zone temperatures. The sensitivity of the control design to external conditions of humidity, ambient temperature, and fuel composition is explored. Extensive simulation was used to determine necessary instrumentation accuracies. The paper concludes with a review of the development testing and the final control system configuration. Author (EI)

A95-84202

FLEX CYCLE COMBUSTOR DEVELOPMENT AND DEMONSTRATION

M. M. HARRIS Allied-Signal Aerospace Co, Phoenix, AZ, United States, D. N. MARSH, E. A. VOS, and E. DURKIN Journal of Engineering for Gas Turbines and Power, Transactions of the ASME (ISSN 0742-4795) vol. 116, no. 3 July 1994 p. 534-541 refs (BTN-94-EIX95011441245) Copyright

An innovative, 'flex-cycle' combustion system has been developed for the Garrett Model 400-1 Integrated Power Unit (IPU), a 425 shp (317 kW) gas turbine engine designed for use on future fighter aircraft. Demonstration of this system required real-time transient operation of the combustor in a full-scale test rig. The transient testing was unique, having been performed with an electronic control, which modulated all combustor operating parameters according to programmed engine component maps, drag curves, fuel schedules, and selected ambient test conditions. The axially injected annular combustor is capable of engine starts in two seconds, as well as producing 200 shp (149 kW) for emergency use at all altitudes up to 50,000 ft (15,240 m). The combustion system is capable of switching operation from the emergency power stored energy (SE) mode to the normal-air breathing (NAB) auxiliary power mode without loss of engine power. The flex-cycle combustor supplies emergency power in the SE mode with a temperature rise of 2200 F (1222 C) and in the NAB mode with a temperature rise of 1600 F (889 C). Specific features that make these requirements possible include air-assisted simplex airblast fuel atomizers with integral check valves, and effusion-cooled combustor liner walls. This paper describes the flex-cycle combustion system design, test methods used, and significant test results. Steady-state performance, in both the SE and NAB operating modes, and real-time transient test results are discussed. The transient testing included rapid starts as well as transitions from the SE to NAB operating regimes. Author (EI)

A95-84203

DEVELOPMENT OF AN AERODERIVATIVE GAS TURBINE DRY LOW EMISSIONS COMBUSTION SYSTEM

G. LEONARD GE Aircraft Engine Business, Cincinnati, OH, United States and J. STEGMAIER Journal of Engineering for Gas Turbines and Power, Transactions of the ASME (ISSN 0742-4795) vol. 116, no. 3 July 1994 p. 542-546 refs (BTN-94-EIX95011441246) Copyright

This paper gives the development status of GE's new aeroderivative premixed combustion system. This system consists of a new fuel staged annular combustor, compressor rear frame, first-stage turbine nozzle, electronic staging controller, and fuel delivery system. Component test results along with a description of the combustion system are presented. This new system will reduce NO(x) emissions by 90 percent relative to the original aircraft engine combustion system while maintaining low emissions of CO and UHCs. Tests of a LM6000 gas turbine equipped with the new system are planned for early 1994. Author (EI)

A95-84209

CONTRIBUTION OF THERMAL RADIATION TO THE TEMPERATURE PROFILE OF CERAMIC COMPOSITE MATERIALS

A. TREMANTE Universidad Simon Bolivar, Caracas, Venezuela and F. MALPICA Journal of Engineering for Gas Turbines and

Power, Transactions of the ASME (ISSN 0742-4795) vol. 116, no. 3 July 1994 p. 583-586 refs (BTN-94-EIX95011441252) Copyright

The steady energy transfer equation for simultaneous conduction and radiation in an absorbing, emitting, and nonscattering gray planar medium is studied theoretically. For extremely high-temperature applications, where radiative transfer plays an important role, ceramic-matrix composites, considered as semitransparent materials, are being explored for potential use in turbine and compressor components, spacecraft structures, engine control systems, and nuclear reactors. Exact solution of the above-mentioned radiative problems is seldom possible and time-consuming numerical approximations are then used. A technique combining an accurate physical formulation, the two-flux model, coupled to a fast numerical procedure for the calculation of the temperature and heat fluxes is described. Author (EI)

A95-84213

CERAMIC COMPOSITE ATTACHMENTS FOR TRANSMISSION OF HIGH-TORQUE LOADS

J. W. BROCKMEYER Rockwell Int Corp, Canoga Park, CA, United States, A. C. STRAUB, and E. J. KRIEG Journal of Engineering for Gas Turbines and Power, Transactions of the ASME (ISSN 0742-4795) vol. 116, no. 3 July 1994 p. 611-615 refs (BTN-94-EIX95011441256) Copyright

The use of fiber-reinforced ceramic matrix composites (FRCMC) for advanced turbopump (T/P) hot-section components offers a number of potential advantages relative to the use of 'conventional' materials. Among these advantages are reduced weight, enhanced life with reduced maintenance, and improved performance achievable by increasing the turbine inlet temperature. FRCMC are, however, emerging materials, and their design and analysis present unique challenges. These composites have relatively low thermal expansion coefficients and low strain-to-failure characteristics, and they have nonlinear, anisotropic properties. These characteristics particularly complicate the design of attachments to mating metallic components within a T/P. In an ongoing program, an FRCMC stator and rotor for a rocket engine T/P are being developed for eventual ground test demonstration. The rotor attachment is designed to transmit high-torque loads and provides an example of a design methodology that is compatible with current analytical capabilities. The approach used and described herein applies an empirically derived materials properties data base in combination with macromechanical analysis to reach a solution to this design challenge. This example demonstrates both the capabilities and the limitations of current design and analysis practices and provides direction for future development. A curvic coupling was chosen to meet the specific design goals and will be fabricated and tested to verify the design. Author (EI)

A95-84553* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EDUCATION, TRAINING, AND HUMAN ENGINEERING IN AEROSPACE; SAE AEROTECH '93, COSTA MESA, CA, SEP. 27-30, 1993

DIANE C. SHAPIRO, editor and R. MICHAEL NORMAN, editor Warrendale, PA Society of Automotive Engineers, Inc. 1993 162 p. (SAE SP-992; ISBN 1-56091-428-9; HTN-95-A1048) Copyright

Advances in simulation technology are discussed by a number of government and industry experts, for both training and research and development applications. Advanced techniques, such as helmet-mounted information displays, neurocontrollers, automated training systems, and simulation for space-based systems are included. Advances in training methodology for air transportation are covered by a group of experts in that field, including discussions of advanced flight deck transition training, new training tools, and effective low cost alternatives for part-task training. With the ever-increasing emphasis on human factors in cockpit and cabin design, the section on research, advances, and certification criteria in that field is pertinent. NASA, aircraft manufacturing, and FAA representatives

have compiled an informative group of presentations concerning active topics and considerations in human factors design. For individual titles, see A95-84554 through A95-84572. Hermer

A95-84731

FLIGHT SIMULATION FATIGUE CRACK GROWTH TESTING OF ALUMINUM ALLOYS

R. J. H. WANHILL National Aerospace Laboratory, Amsterdam, The Netherlands International Journal of Fatigue (ISSN 0142-1123) vol. 16, no. 2 February 1994 p. 99-110 (HTN-95-00652) Copyright

Flight simulation fatigue crack growth tests are necessary for verification of aircraft damage tolerance analyses and crack growth prediction methods, and also for comparing candidate materials for aircraft structural applications. However, such tests involve complicating issues that have emerged from many investigations on aluminum alloys since the late 1960s. These issues are reviewed to provide guidelines for further testing. Author (Hermer)

A95-84786

FORMING AND BONDING TECHNIQUES FOR HIGH-STRENGTH ALUMINUM ALLOYS

HORST E. FRIEDRICH MTU Deutsche Aerospace, Munich, Germany JOM (ISSN 1047-4838) vol. 47, no. 2 February 1995 p. 33-35

(HTN-95-20605) Copyright

This article highlights the continued preference for aluminum as a structural material for aircraft, where demands for high performance coupled with the need for weight reduction have led to the use of high-strength aluminum alloys. The ever-increasing demand for a high level of integration of complex structural components calls for the development of appropriate manufacturing processes. As an example, superplastic forming is discussed, combined with innovative bonding techniques such as diffusion bonding and adhesive spot welding. Author (Hermer)

A95-84992

THE POTENTIAL FOR CMCS TO REPLACE SUPERALLOYS IN ENGINE EXHAUST DUCTS

RICHARD ROTH Massachusetts Institute of Technology, Cambridge, MA, US, JOEL P. CLARK Massachusetts Institute of Technology, Cambridge, MA, US, and FRANK R. FIELD, III Massachusetts Institute of Technology, Cambridge, MA, US JOM (ISSN 1047-4838) vol. 46, no. 1 January 1994 p. 32-35 (HTN-95-42298) Copyright

The Materials Systems Laboratory at the Massachusetts Institute of Technology has conducted research to develop decision tools that can facilitate materials selection and provide a deeper understanding of the design tradeoffs that occur when choosing among advanced aerospace materials for high-temperature applications. As an illustration of the use of these tools, this paper describes research done to evaluate the material alternatives currently under consideration for exhaust ducts in aircraft gas turbine engines. Although nickel-based superalloys currently prevail for this application, the increasing temperatures of modern engines are necessitating the usage of higher temperature materials. Author (Hermer)

A95-85062* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SHEAR BUCKLING RESPONSE OF TAILORED COMPOSITE PLATES

SHERRILL B. BIGGERS Clemson Univ., Clemson, SC, US and STEPHANE S. PAGEAU Clemson Univ., Clemson, SC, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 5 May 1994 p. 1100-1102 (Contract(s)/Grant(s): NAG1-1141) (HTN-95-51680) Copyright

This Note evaluates the piecewise-uniform approach to tailoring as a mean of improving the shear buckling loads of composite plates. This design approach is referred to herein as stiffness tailoring or, more simply, as tailoring. The primary objectives are to determine the tailoring patterns and the degree of concentration of

the material used to achieve the tailoring in each pattern that maximize the shear buckling load and to quantify the maximum relative improvement that can be achieved in the buckling load compared to uniform plates. Author (revised by Hermer)

A95-86165* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

STATIONARY PREMIXED FLAMES IN SPHERICAL AND CYLINDRICAL GEOMETRIES

P. D. RONNEY University of Southern California, Los Angeles, CA, US, K. N. WHALING Princeton University, Princeton, NJ, US, A. ABBUD-MADRID Princeton University, Princeton, NJ, US, J. L. GATTO Princeton University, Princeton, NJ, US, and V. L. PISOWISZ Princeton University, Princeton, NJ, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 3 March 1994 p. 569-577 (Contract(s)/Grant(s): NAG3-965; NAG3-1242; NAG3-1523) (HTN-95-42336) Copyright

Stationary source-free spherical flames ('flame balls') in premixed combustible gases were studied by employing low-gravity (micro-g) environments in a drop tower and an aircraft flying parabolic trajectories to diminish the impact of buoyancy-induced convective flow. Flame balls were found in all mixture families tested when: (1) the Lewis number Le of the deficient reactant was sufficiently low; and (2) the compositions were sufficiently close to the flammability limits. Probably as a consequence of the reduction in buoyant convection, the flammability limits at micro-g were significantly more dilute than those at Earth gravity; for example, 3.35% H_2 vs 4.0% H_2 in lean H_2 -air mixtures. By comparison with analytical and computational models, it is inferred that the phenomenon is probably related to diffusive-thermal effects in low- Le mixtures in conjunction with flame-front curvature and radiative heat losses from the combustion products. The chemical reaction mechanism appears to play no qualitative role. In the aircraft experiments, the gravity levels (approximately equal $10(\exp -2)g(\text{sub } 0)$) were found to cause noticeable motion of flame balls due to buoyancy, which in turn influenced the behavior of flame balls. At these g levels, a new type of transient, nearly cylindrical flame structure, termed 'flame strings,' was observed. Author (Hermer)

A95-86197

NON-LINEAR ANALYSIS PROVIDES NEW INSIGHTS INTO IMPACT DAMAGE OF COMPOSITE STRUCTURES

D. MURPHY Boeing Computer Services, US Composites (ISSN 0010-4361) vol. 25, no. 1 January 1994 p. 65-69 (HTN-95-42368) Copyright

Structural dynamic simulation of some instrumented impact testing was performed in support of the Advanced Technology Composite Aircraft Structures (ATCAS) program. Large, graphite/epoxy stringer stiffened panels, representing transport aircraft fuselage structure, were fabricated and subjected to a range of lateral impact events, encompassing both low velocity-high mass projectiles and high velocity-low mass projectiles. These panels were clamped between pine supports (of dimensions 50.8 x 101.6 mm (2 x 4) in), and measurements of force, displacement and velocity were recorded against time. A wide range of panel geometries, stiffener designs, materials and impact locations was studied. In all these tests, questions were raised about the measured frequency content of the impactor force/time histories, particularly those of the high velocity tests. Author (Hermer)

N95-26417 Yale Univ., New Haven, CT. High Temperature Chemical Reaction Engineering Lab.

TRANSPORT PHENOMENA AND INTERFACIAL KINETICS IN MULTIPHASE COMBUSTION SYSTEMS Final Report, 15 Feb. 1991 - 14 Feb. 1994

DANIEL E. ROSNER Mar. 1994 45 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (Contract(s)/Grant(s): AF-AFOSR-0170-91; AF PROJ. 2308) (AD-A288297; AFOSR-94-0691TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The performance of ramjets burning slurry fuels (leading to condensed oxide aerosols and liquid film deposits), gas turbine engines in dusty or marine atmospheres, or when using fuels from non-traditional sources, depends upon the formation and transport of small particles across non-isothermal combustion gas boundary layers (BLs). Even airbreathing engines burning "clean" hydrocarbon fuels can experience soot formation/deposition problems (e.g., combustor liner burnout, accelerated turbine blade erosion and 'hot' corrosion). Moreover, particle formation and transport are important in many chemical reactors used to synthesize or process aerospace materials (turbine blade coatings, optical waveguides, ceramic precursor powders, fibers for composites,...) Accordingly, our research is directed toward providing chemical propulsion systems engineers and materials-oriented engineers with new techniques and quantitative information on important particle- and vapor-mass transport mechanisms and rates. The purpose of this report is to summarize our research methods accomplishments. DTIC

N95-26523# National Aerospace Lab., Tokyo (Japan). Aeroengine Div.

NUMERICAL SIMULATION OF COMBUSTION FLOW AROUND A FLAME HOLDER WITH HYDROGEN INJECTION
TAKESHI YAMAMOTO and TAKASHI TAMARU Apr. 1994 17 p In JAPANESE Original contains color illustrations (ISSN 0389-4010)
(NAL-TR-1233) Avail: CASI HC A03/MF A01

In the National Aerospace Laboratory, research work on a hydrogen-fueled ramjet engine for the spaceplane is being carried out. As a part of their research, a bluff-body type flame holder with fuel injection was tested at atmospheric conditions and prospective results were obtained for the engine. However, the capability of the experimental facility was limited, and it was difficult to investigate the engine performance over a wide operating range. So a two-dimensional CFD (Computational Fluid Dynamics) code was developed to simulate engine performance over a wide operating range. The code is based on the SIMPLER algorithm, and the power law scheme is used for the discretization of the governing equations. Turbulence is simulated by Myong-Kasagi's low Reynolds number type k-epsilon model. Magnussen's eddy-dissipation concept is used to simulate the combustion. In this report, details of the CFD code and some typical results of the numerical simulation are described. Author

N95-26842 Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

A NUMERICAL MODEL TO PREDICT THE FATE OF JETTISONED AVIATION FUEL M.S. Thesis
KARL DURANT PFEIFFER Dec. 1994 107 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A289336; AFIT/GCS/ENC/94D-01) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

While airborne, military and civilian aircraft must occasionally jettison unburned aviation fuel into the atmosphere. This research investigates the fate of a jettisoned fuel (e.g. JP-4, JP-8, etc.) from initial release to final ground fall by numerically modeling the physical phenomena governing the fate of this fuel: evaporation, advection, and dispersion. Using previous work in evaporation and free fall of fuel droplets as a foundation, this thesis presents an integrated evaporation advection and dispersion model designed to run under the resources of a typical personal computer. This integrated model is capable of using near real-time meteorological data (i.e. vertical profiles of temperature, pressure and wind) in all model calculations. Physical assumptions in the numerical model are presented, along with sample model calculations supporting these assumptions. Model calculations performed for two jettison scenarios show good agreement with previously published results. DTIC

N95-27167*# Texas Univ., San Antonio, TX. Engineering Div.
PROBABILISTIC MATERIAL STRENGTH DEGRADATION

MODEL FOR INCONEL 718 COMPONENTS SUBJECTED TO HIGH TEMPERATURE, HIGH-CYCLE AND LOW-CYCLE MECHANICAL FATIGUE, CREEP AND THERMAL FATIGUE EFFECTS Final Technical Report, Jun. 1992 - Jan. 1995
CALLIE C. BAST and LOLA BOYCE Jan. 1995 86 p
(Contract(s)/Grant(s): NAG3-867)
(NASA-CR-197832; NAS 1.26:197832) Avail: CASI HC A05/MF A01

This report presents the results of both the fifth and sixth year effort of a research program conducted for NASA-LeRC by The University of Texas at San Antonio (UTSA). The research included on-going development of methodology for a probabilistic material strength degradation model. The probabilistic model, in the form of a postulated randomized multifactor equation, provides for quantification of uncertainty in the lifetime material strength of aerospace propulsion system components subjected to a number of diverse random effects. This model is embodied in the computer program entitled PROMISS, which can include up to eighteen different effects. Presently, the model includes five effects that typically reduce lifetime strength: high temperature, high-cycle mechanical fatigue, low-cycle mechanical fatigue, creep and thermal fatigue. Statistical analysis was conducted on experimental Inconel 718 data obtained from the open literature. This analysis provided regression parameters for use as the model's empirical material constants, thus calibrating the model specifically for Inconel 718. Model calibration was carried out for five variables, namely, high temperature, high-cycle and low-cycle mechanical fatigue, creep and thermal fatigue. Methodology to estimate standard deviations of these material constants for input into the probabilistic material strength model was developed. Using an updated version of PROMISS, entitled PROMISS93, a sensitivity study for the combined effects of high-cycle mechanical fatigue, creep and thermal fatigue was performed. Then using the current version of PROMISS, entitled PROMISS94, a second sensitivity study including the effect of low-cycle mechanical fatigue, as well as, the three previous effects was performed. Results, in the form of cumulative distribution functions, illustrated the sensitivity of lifetime strength to any current value of an effect. In addition, verification studies comparing a combination of high-cycle mechanical fatigue and high temperature effects by model to the combination by experiment were conducted. Thus, for Inconel 718, the basic model assumption of independence between effects was evaluated. Results from this limited verification study strongly supported this assumption. Author

N95-27656*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

HARDWARE CLEANLINESS METHODOLOGY AND CERTIFICATION

GALE A. HARVEY, THOMAS J. LASH, and J. RICHARD RAWLS *In its LDEF: 69 Months in Space. Third Post-Retrieval Symposium, Part 3* p 1237-1243 Feb. 1995
Avail: CASI HC A02/MF A04

Inadequacy of mass loss cleanliness criteria for selection of materials for contamination sensitive uses, and processing of flight hardware for contamination sensitive instruments is discussed. Materials selection for flight hardware is usually based on mass loss (ASTM E-595). However, flight hardware cleanliness (MIL 1246A) is a surface cleanliness assessment. It is possible for materials (e.g. Sil-Pad 2000) to pass ASTM E-595 and fail MIL 1246A class A by orders of magnitude. Conversely, it is possible for small amounts of nonconforming material (Huma-Seal conformal coating) to not present significant cleanliness problems to an optical flight instrument. Effective cleaning (precleaning, precision cleaning, and ultra cleaning) and cleanliness verification are essential for contamination sensitive flight instruments. Polish cleaning of hardware, e.g. vacuum baking for vacuum applications, and storage of clean hardware, e.g. laser optics, is discussed. Silicone materials present special concerns for use in space because of the rapid conversion of the outgassed residues to glass by solar

11 CHEMISTRY AND MATERIALS

ultraviolet radiation and/or atomic oxygen. Non ozone depleting solvent cleaning and institutional support for cleaning and certification are also discussed. Author

N95-27851# Los Alamos National Lab., NM.

A LABORATORY SCALE SUPERSONIC COMBUSTIVE FLOW SYSTEM

E. C. SAMS, D. K. ZERKLE, H. A. FRY, and P. J. WANTUCK 1995 16 p Presented at the 33rd American Institute of Aeronautics and Astronautics (AIAA) Aerospace Sciences Meeting, Reno, NV, 9-12 Jan. 1995

(Contract(s)/Grant(s): W-7405-ENG-36)

(DE95-006347; LA-UR-95-42; CONF-950130-7) Avail: CASI HC A03/MF A01

A laboratory scale supersonic flow system (Combustive Flow System (CFS)) which utilizes the gaseous products of methane-air and/or liquid fuel-air combustion has been assembled to provide a propulsion type exhaust flow field for various applications. Such applications include providing a testbed for the study of planar two-dimensional nozzle flow fields with chemistry, three-dimensional flow field mixing near the exit of rectangular nozzles, benchmarking the predictive capability of various computational fluid dynamic codes, and the development and testing of advanced diagnostic techniques. This paper provides a detailed description of the flow system and data related to its operation. DOE

N95-28152 Coordinating Research Council, Inc., Atlanta, GA. THE EFFECT OF AVIATION FUELS CONTAINING LOW AMOUNTS OF STATIC DISSIPATER ADDITIVE ON ELECTROSTATIC CHARGE GENERATION

May 1994 132 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(AD-A280075) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The purpose of the CRC program was to determine whether commingled fuels containing low levels of static dissipater additive pose any additional electrostatic hazard over unadditized fuel. Specifically, the program conducted the necessary experiments to determine electrostatic effects of commingled fuels containing static dissipater additive with a conductivity less than 50 pico-Siemens/meter (pS/m). It was also a goal of this program to survey existing systems and make an assessment whether future fueling systems could cause additional electrostatic hazards during the fueling operation. In order to achieve these goals, it was the scope of this program: to assess the range of conductivities present in Jet A at various locations; to assess the charging tendency of Jet A presently being used in the United States; to perform laboratory scale tests to further study the charging tendency of ASA-3 and Stadis 450 in both commingled Jet A and clay treated Jet A as needed to verify the results of the other tests; and to develop a database of the residence times typical of existing fueling systems. DTIC

N95-28266*# Federal Aviation Administration, Washington, DC.

NINTH DOD/NASA/FAA CONFERENCE ON FIBROUS COMPOSITES IN STRUCTURAL DESIGN, VOLUME 3

JOSEPH R. SODERQUIST, comp., LAWRENCE M. NERI, comp. (Federal Aviation Administration, Atlantic City, NJ.), and HERMAN L. BOHON, comp. (Galaxy Scientific Corp., Hampton, VA.) Sep. 1992 483 p Conference held in Lake Tahoe, NV, 4-7 Nov. 1991; sponsored by NASA, AF, Army, and Navy Sponsored by NASA (NASA-CR-198718; NAS 1.26:198718; DOT/FAA/CT-92-25-VOL-3) Copyright Avail: CASI HC A21/MF A04

This publication contains the proceedings of the Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design held at Lake Tahoe, Nevada, during 4-7 Nov. 1991. Presentations were made in the following areas of composite structural design: perspectives in composites, design methodology, design applications, design criteria, supporting technology, damage tolerance, and manufacturing. For individual titles, see N95-28267 through N95-28293.

N95-28267*# Lockheed Aeronautical Systems Co., Burbank, CA. Composites Development Center.

PROCESS AND CONTROL SYSTEMS FOR COMPOSITES MANUFACTURING

T. H. TSIANG and JOHN L. WANAMAKER (Lockheed Aeronautical Systems Co., Marietta, GA.) In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 3 p 1153-1162 Sep. 1992

Copyright Avail: CASI HC A02/MF A04

A precise control of composite material processing would not only improve part quality, but it would also directly reduce the overall manufacturing cost. The development and incorporation of sensors will help to generate real-time information for material processing relationships and equipment characteristics. In the present work, the thermocouple, pressure transducer, and dielectrometer technologies were investigated. The monitoring sensors were integrated with the computerized control system in three non-autoclave fabrication techniques: hot-press, self contained tool (self heating and pressurizing), and pressure vessel). The sensors were implemented in the parts and tools. Author

N95-28268*# General Dynamics/Convair, San Diego, CA.

DEVELOPMENT OF A LOW-COST, MODIFIED RESIN TRANSFER MOLDING PROCESS USING ELASTOMERIC TOOLING AND AUTOMATED PREFORM FABRICATION

WILLIAM J. DOANE and RONALD G. HALL In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 3 p 1163-1173 Sep. 1992

Copyright Avail: CASI HC A03/MF A04

This paper describes the design and process development of low-cost structural parts made by a modified resin transfer molding process. Innovative application of elastomeric tooling to increase laminate fiber volume and automated forming of fiber preforms are discussed, as applied to fabrication of a representative section of a cruise missile fuselage. Author

N95-28270*# Sikorsky Aircraft, Stratford, CT.

STATIC AND FATIGUE TESTING OF FULL-SCALE FUSELAGE PANELS FABRICATED USING A THERM-X(R) PROCESS

ALBERT J. DINICOLA, CHRISTOS KASSAPOGLOU, and JACK C. CHOU In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 3 p 1185-1210 Sep. 1992 (Contract(s)/Grant(s): NAS1-18799)

Copyright Avail: CASI HC A03/MF A04

Large, curved, integrally stiffened composite panels representative of an aircraft fuselage structure were fabricated using a Therm-X process, an alternative concept to conventional two-sided hard tooling and contour vacuum bagging. Panels subsequently were tested under pure shear loading in both static and fatigue regimes to assess the adequacy of the manufacturing process, the effectiveness of damage tolerant design features co-cured with the structure, and the accuracy of finite element and closed-form predictions of postbuckling capability and failure load. Test results indicated the process yielded panels of high quality and increased damage tolerance through suppression of common failure modes such as skin-stiffener separation and frame-stiffener corner failure. Finite element analyses generally produced good predictions of postbuckled shape, and a global-local modelling technique yielded failure load predictions that were within 7% of the experimental mean. Author

N95-28271*# Hercules Aerospace Co., Magna, UT. Composite Structures Group.

ADVANCED TOW PLACEMENT OF COMPOSITE FUSELAGE STRUCTURE

ROBERT L. ANDERSON and CARROLL G. GRANT In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 3 p 1211-1222 Sep. 1992

Copyright Avail: CASI HC A03/MF A04

The Hercules NASA ACT program was established to demon-

strate and validate the low cost potential of the automated tow placement process for fabrication of aircraft primary structures. The program is currently being conducted as a cooperative program in collaboration with the Boeing ATCAS Program. The Hercules advanced tow placement process has been in development since 1982 and was developed specifically for composite aircraft structures. The second generation machine, now in operation at Hercules, is a production-ready machine that uses a low cost prepreg tow material form to produce structures with laminate properties equivalent to prepreg tape layup. Current program activities are focused on demonstration of the automated tow placement process for fabrication of subsonic transport aircraft fuselage crown quadrants. We are working with Boeing Commercial Aircraft and Douglas Aircraft during this phase of the program. The Douglas demonstration panels has co-cured skin/stringers, and the Boeing demonstration panel is an intricately bonded part with co-cured skin/stringers and co-bonded frames. Other aircraft structures that were evaluated for the automated tow placement process include engine nacelle components, fuselage pressure bulkheads, and fuselage tail cones. Because of the cylindrical shape of these structures, multiple parts can be fabricated on one tow placement tool, thus reducing the cost per pound of the finished part. Author

**N95-28273*# Atlantic Research Corp., Alexandria, VA.
THROUGH-THE THICKNESS(R) BRAIDED COMPOSITES
FOR AIRCRAFT APPLICATIONS**

RICHARD T. BROWN In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 3 p 1231-1247 Sep. 1992

Copyright Avail: CASI HC A03/MF A04

Material and structural specimens of Through-the-Thickness(R) braided textile composites were tested in a variety of experiments. The results have demonstrated that the preform architecture provides significant payoffs in damage tolerance, delamination resistance, and attachment strength. This paper describes the braiding process, surveys the experimental data base, and illustrates the application of three dimensional braiding in aircraft structures. Author

**N95-28274*# McDonnell Aircraft Co., Saint Louis, MO.
ACT/ICAPS: THERMOPLASTIC COMPOSITE ACTIVITIES**

M. P. RENIERI, S. J. BURPO, L. M. ROUNDY, and S. M. TODD In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 3 p 1253-1288 Sep. 1992

Copyright Avail: CASI HC A03/MF A04

McDonnell Aircraft Company (MCAIR) is teamed with Douglas Aircraft Company (DAC) under NASA's Advanced Composite Technology (ACT) initiative in a program entitled Innovative Composite Aircraft Primary Structures (ICAPS). Efforts at MCAIR have focused on the use of thermoplastic composite materials in the development of structural details associated with an advanced fighter fuselage section with applicability to transport design. Based on innovative design/manufacturing concepts for the fuselage section primary structure, elements were designed, fabricated, and structurally tested. These elements focused on key issues such as thick composite lugs and low cost forming of fastenerless, stiffener/moldline concepts. Manufacturing techniques included autoclave consideration, single diaphragm co-consolidation (SDCC), and roll-forming. Author

**N95-28276*# National Aeronautics and Space Administration.
Langley Research Center, Hampton, VA.**

**RESIN TRANSFER MOLDING OF TEXTILE PREFORMS FOR
AIRCRAFT STRUCTURAL APPLICATIONS**

GREGORY H. HASKO (Lockheed Engineering and Sciences Co., Hampton, VA.), H. BENSON DEXTER, and MARK H. WEIDEMAN (Virginia Polytechnic Inst. and State Univ., Blacksburg, VA.) In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 3 p 1303-1315 Sep. 1992

Copyright Avail: CASI HC A03/MF A04

The NASA LaRC is conducting and supporting research to develop cost-effective fabrication methods that are applicable to

primary composite aircraft structures. One of the most promising fabrication methods that has evolved is resin transfer molding (RTM) of dry textile material forms. RTM has been used for many years for secondary structures, but has received increased emphasis because it is an excellent method for applying resin to damage-tolerant textile preforms at low cost. Textile preforms based on processes such as weaving, braiding, knitting, stitching, and combinations of these have been shown to offer significant improvements in damage tolerance compared to laminated tape composites. The use of low-cost resins combined with textile preforms could provide a major breakthrough in achieving cost-effective composite aircraft structures. RTM uses resin in its lowest cost form, and storage and spoilage costs are minimal. Near net shape textile preforms are expected to be cost-effective because automated machines can be used to produce the preforms, post-cure operations such as machining and fastening are minimized, and material scrap rate may be reduced in comparison with traditional prepreg molding. The purpose of this paper is to discuss experimental and analytical techniques that are under development at NASA Langley to aid the engineer in developing RTM processes for airframe structural elements. Included are experimental techniques to characterize preform and resin behavior and analytical methods that were developed to predict resin flow and cure kinetics. Author

**N95-28289*# McDonnell Aircraft Co., Saint Louis, MO.
ANALYSIS TECHNIQUES FOR THE PREDICTION OF
SPRINGBACK IN FORMED AND BONDED COMPOSITE
COMPONENTS**

MICHAEL F. GASICK and GARY D. RENIERI In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 3 p 1539-1558 Sep. 1992

Copyright Avail: CASI HC A03/MF A04

Two finite element analysis codes are used to model the effects of cooling on the dimensional stability of formed and bonded composite parts. The two analysis routines, one h-version and one p-version, are compared for modeling time, analysis execution time, and exactness of solution as compared to actual test results. A recommended procedure for predicting temperature effects on composite parts is presented, based on the results of this study. Author

**N95-28420*# Galaxy Scientific Corp., Hampton, VA.
NINTH DOD/NASA/FAA CONFERENCE ON FIBROUS
COMPOSITES IN STRUCTURAL DESIGN, VOLUME 1**

JOSEPH R. SODERQUIST, comp., LAWRENCE M. NERI, comp. (Federal Aviation Administration, Atlantic City, NJ.), and HERMAN L. BOHON, comp. (Galaxy Scientific Corp., Hampton, VA.) Sep. 1992 548 p Conference held in Lake Tahoe, NV, 4-7 Nov. 1991; sponsored by NASA, AF, Army, and Navy Sponsored by NASA (NASA-CR-198723; NAS 1.26:198723; DOT/FAA/CT-92-25-VOL-1) Avail: CASI HC A23/MF A04

This publication contains the proceedings of the Ninth DOD/NASA/FAA conference on Fibrous Composites in structural Design. Presentations were made in the following areas of composite structural design: perspectives in composites; design methodology; design applications; design criteria; supporting technology; damage tolerance; and manufacturing. For individual titles, see N95-28421 through N95-28446.

**N95-28421*# Army Materiel Command, Aberdeen Proving Ground,
MD.**

**UTILIZATION OF COMPOSITE MATERIALS BY THE US
ARMY: A LOOK AHEAD**

RICHARD CHAIT In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 7-34 Sep. 1992

Avail: CASI HC A03/MF A04

An overview of the use of composite materials in the Army is given. Important efforts to document design information, supporting research, and some national applications for composite materials are given. The use of Kevlar fiber in both vests and helmets for the

soldier is outlined. The advantages of using fiberglass in the hull of the Bradley fighting ground vehicle is given. The full potential of composite materials is realized in the recently awarded LH Comanche RAH-66 program. The use of composites for application to rocket motor uses, wings, fins, and casings is under development. Because of the uncertain funding profile, it is more important than ever that technology planning provide the basis for effective prioritization and leveraging of the tech base efforts involving advanced materials. CASI

N95-28422*# Naval Air Development Center, Warminster, PA.
BENEFITS AND LIMITATIONS OF COMPOSITES IN CARRIER-BASED AIRCRAFT
 DONALD P. MCERLEAN *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 35-92 Sep. 1992
 Avail: CASI HC A04/MF A04

There are many unique aspects of Navy air missions that lead to the differentiation between the design and performance of ship and shore-based aircraft. The major aspects are discussed from which essentially all Navy aircraft design requirements derive. (1) Navy aircraft operate from carriers at sea imposes a broad spectrum of physical conditions, constraints, and requirements ranging from the harsh sea environment, the space limitations of a carrier, takeoff and landing requirements as well as for endurance at long distances from the carrier. (2) Because the carrier and its airwing are intended to be capable of responding to a broad range of contingencies, mission flexibility is essential (maximum weapon carriage, rapid reconfiguration, multiple mission capability). (3) The embarked aircraft provides the long range defense of the battle group against air, surface and subsurface launched antiship missiles. (4) The carrier and its aircraft must operate independently and outside of normal supply lines. Taking into account these aspects, the use of composite materials in the design and performance of naval aircraft is outlined, also listing advantages and disadvantages. Author

N95-28426*# Delaware Univ., Newark, DE. Dept. of Mechanical Engineering.
THE EFFECT OF MATERIAL HETEROGENEITY IN CURVED COMPOSITE BEAMS FOR USE IN AIRCRAFT STRUCTURES
 BRENDAN J. OTOOLE and MICHAEL H. SANTARE *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 157-166 Sep. 1992
 (Contract(s)/Grant(s): NAS1-18758)
 Avail: CASI HC A02/MF A04

A design tool is presented for predicting the effect of material heterogeneity on the performance of curved composite beams for use in aircraft fuselage structures. Material heterogeneity can be induced during processes such as sheet forming and stretch forming of thermoplastic composites. This heterogeneity can be introduced in the form of fiber realignment and spreading during the manufacturing process causing a gradient in material properties in both the radial and tangential directions. The analysis procedure uses a separate two-dimensional elasticity solution for the stresses in the flanges and web sections of the beam. The separate solutions are coupled by requiring the forces and displacements match at the section boundaries. Analysis is performed for curved beams loaded in pure bending and uniform pressure. The beams can be of any general cross-section such as a hat, T-, I-, or J-beam. Preliminary results show that geometry of the beam dictates the effect of heterogeneity on performance. Heterogeneity plays a much larger role in beams with a small average radius to depth ratio, R/t , where R is the average radius of the beam and t is the difference between the inside and outside radius. Results of the analysis are in the form of stresses and displacements, and they are compared to both mechanics of materials and numerical solutions obtained using finite element analysis. Author

N95-28427*# Boeing Defense and Space Group, Seattle, WA. Military Airplane Div.

INVESTIGATION OF STATIC AND CYCLIC BEARING FAILURE MECHANISMS FOR GR/EP LAMINATES

R. W. WALTER and M. M. TUTTLE *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 167-184 Sep. 1992
 Avail: CASI HC A03/MF A04

Static, cyclic load (fatigue), and residual strength testing of graphite-epoxy (GR/EP) and aluminum pin bearing joints was completed to study bearing failure mechanisms. Parameters investigated included static strength, failure mode, fatigue life, hole growth, joint stiffness, and residual strength. Comparative evaluation of these results show that the MIL-HDBK-5 convention for the definition of bearing strength can be used for GR/EP materials while maintaining the same, or improved, level of structural integrity shown for metal joints. Author

N95-28429*# Northrop Corp., Hawthorne, CA. Aircraft Div.
ANALYSIS OF COMPOSITE STRUCTURES WITH DELAMINATIONS UNDER COMBINED BENDING AND COMPRESSION

HAN-PIN KAN, EDWARD KAUTZ (Naval Air Development Center, Warminster, PA.), and LARRY NERI (Federal Aviation Administration, Atlantic City, NJ.) *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 197-218 Sep. 1992
 (Contract(s)/Grant(s): N62269-90-C-0282)
 Avail: CASI HC A03/MF A04

A methodology had been developed for strength prediction of composite structures with delaminations under combined bending and compression loads. The methodology is an extension of the delamination analysis method developed under the USAF/Boeing/Northrop 'Damage Tolerance of Composites' program. Delamination buckling and strain energy release rate analyses are used as basic tools in the strength prediction. In addition, failure mode interaction and structural configuration effects are considered. The influence of fasteners on the strength of a delaminated structure is incorporated to evaluate assembly-caused delaminations. The capabilities and limitations of the analysis method are shown by correlating the analytical results with the existing experimental data. The failure load, failure mode and failure sequence of a structure containing delaminations are predicted and the analytical results are compared with test data. Author

N95-28432*# Boeing Defense and Space Group, Philadelphia, PA. Helicopters Div.
APPLICATION OF ADVANCED MATERIAL SYSTEMS TO COMPOSITE FRAME ELEMENTS
 STEVEN LLORENTE, PIERRE MINGUET, RUSSELL FAY, and STEVEN MEDWIN (Du Pont de Nemours, E. I. and Co., Wilmington, DE.) *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 277-295 Sep. 1992
 Avail: CASI HC A03/MF A04

A three phase program has been conducted to investigate DuPont's Long Discontinuous Fiber (LDF) composites. Additional tests were conducted to compare LDF composites against toughened thermosets and a baseline thermoset system. Results have shown that the LDF AS4/PEKK offers improved interlaminar (flange bending) strength with little reduction in mechanical properties due to the discontinuous nature of the fibers. In the third phase, a series of AS4/PEKK LDF C-section curved frames (representing a typical rotorcraft light frame) were designed, manufactured and tested. Specimen reconsolidation after 'stretch forming' and frame thickness were found to be key factors in this light frame's performance. A finite element model was constructed to correlate frame test results with expected strain levels determined from material property tests. Adequately reconsolidated frames performed well and failed at strain levels at or above baseline thermoset material test strains. Finally a cost study was conducted which has shown that the use of LDF for this frame would result in a significant cost savings, for moderate to large lot sizes compared with the hand lay-up of a thermoset frame. Author

N95-28435*# Virginia Polytechnic Inst. and State Univ., Blacksburg, VA. Dept. of Engineering Science and Mechanics.

VIBRATIONAL BEHAVIOR OF ADAPTIVE AIRCRAFT WING STRUCTURES MODELLED AS COMPOSITE THIN-WALLED BEAMS

O. SONG, L. LIBRESCU, and C. A. ROGERS *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 361-381 Sep. 1992

(Contract(s)/Grant(s): N00014-88-C-0721)

Avail: CASI HC A03/MF A04

The vibrational behavior of cantilevered aircraft wings modeled as thin-walled beams and incorporating piezoelectric effects is studied. Based on the converse piezoelectric effect, the system of piezoelectric actuators conveniently located on the wing yield the control of its associated vertical and lateral bending eigenfrequencies. The possibility revealed by this study enabling one to increase adaptively the eigenfrequencies of thin-walled cantilevered beams could play a significant role in the control of the dynamic response and flutter of wing and rotor blade structures. Author

N95-28436*# California Univ., Davis, CA.

UNIQUE CONSIDERATIONS IN THE DESIGN AND EXPERIMENTAL EVALUATION OF TAILORED WINGS WITH ELASTICALLY PRODUCED CHORDWISE CAMBER

LAWRENCE W. REHFELD, PETER J. ZISCHKA, MICHAEL L. FENTRESS, and STEPHEN CHANG *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 383-400 Sep. 1992

(Contract(s)/Grant(s): NAS1-18754)

Avail: CASI HC A03/MF A04

Some of the unique considerations that are associated with the design and experimental evaluation of chordwise deformable wing structures are addressed. Since chordwise elastic camber deformations are desired and must be free to develop, traditional rib concepts and experimental methodology cannot be used. New rib design concepts are presented and discussed. An experimental methodology based upon the use of a flexible sling support and load application system has been created and utilized to evaluate a model box beam experimentally. Experimental data correlate extremely well with design analysis predictions based upon a beam model for the global properties of camber compliance and spanwise bending compliance. Local strain measurements exhibit trends in agreement with intuition and theory but depart slightly from theoretical perfection based upon beam-like behavior alone. It is conjectured that some additional refinement of experimental technique is needed to explain or eliminate these (minor) departures from asymmetric behavior of upper and lower box cover strains. Overall, a solid basis for the design of box structures based upon the bending method of elastic camber production has been confirmed by the experiments. Author

N95-28437*# Northrop Corp., Hawthorne, CA.

C-130 ADVANCED TECHNOLOGY CENTER WING BOX CONCEPTUAL DESIGN/COST STUDY

R. S. WHITEHEAD, C. R. FOREMAN (LTV Aerospace Corp., Dallas, TX.), and K. SILVA (Wright Lab., Wright-Patterson AFB, OH.) *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 401-419 Sep. 1992

(Contract(s)/Grant(s): F33657-90-D-0027)

Avail: CASI HC A03/MF A04

A conceptual design was developed by Northrop/LTV for an advanced C-130 Center Wing Box (CWB) which could meet the severe mission requirements of the SOF C-130 aircraft. The goals for the advanced technology CWB relative to the current C-130H CWB were: (1) the same acquisition cost; (2) lower operating support costs; (3) equal or lower weight; (4) a 30,000 hour service life for the SOF mission; and (5) minimum impact on the current maintenance concept. Initially, the structural arrangement, weight, external and internal loads, fatigue spectrum, flutter envelope and design criteria for the SOF C-130 aircraft CWB were developed. An advanced materials assessment was then conducted to determine

the suitability of advanced materials for a 1994 production availability and detailed trade studies were performed on candidate CWB conceptual designs. Finally, a life-cycle cost analysis was performed on the advanced CWB. The study results showed that a hybrid composite/metallic CWB could meet the severe SOF design requirements, reduce the CWB weight by 14 pct., and was cost effective relative to an all metal beefed up C-130H CWB. Author

N95-28438*# McDonnell Aircraft Co., Saint Louis, MO.
DEVELOPMENT OF COMPOSITE CARRYTHROUGH BULKHEAD

R. J. EHLEN and M. LIBESKIND (Naval Air Development Center, Warminster, PA.) *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 421-441 Sep. 1992

(Contract(s)/Grant(s): N62269-87-C-0216)

Avail: CASI HC A03/MF A04

A structural development program was recently completed in which the weight and fatigue advantages of an all composite major load carrying bulkhead was successfully demonstrated. Fabrication of a full scale article, including static and fatigue testing of the carry-through beam portion verified the producibility, strength and durability of this design, thereby presenting the opportunity for use on aircraft upgrades and new aircraft. A 15% weight saving is achievable and, more importantly, the fatigue problems that normally plague metal bulkheads are virtually eliminated. Derived from text

N95-28439*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EFFECTS OF FLOOR LOCATION ON RESPONSE OF COMPOSITE FUSELAGE FRAMES

HUEY D. CARDEN, LISA E. JONES, and EDWIN L. FASANELLA (Lockheed Engineering and Sciences Co., Hampton, VA.) *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 443-457 Sep. 1992

Avail: CASI HC A03/MF A04

Experimental and analytical results are presented which show the effect of floor placement on the structural response and strength of circular fuselage frames constructed of graphite-epoxy composite material. The research was conducted to study the behavior of conventionally designed advanced composite aircraft components. To achieve desired new designs which incorporate improved energy absorption capabilities requires an understanding of how these conventional designs behave under crash type loadings. Data are presented on the static behavior of the composite structure through photographs of the frame specimen, experimental strain distributions, and through analytical data from composite structural models. An understanding of this behavior can aid the dynamist in predicting the crash behavior of these structures and may assist the designer in achieving improved designs for energy absorption and crash behavior of future structures. Derived from text

N95-28441*# Northrop Corp., Hawthorne, CA. Aircraft Div.
RELIABILITY ANALYSIS OF COMPOSITE STRUCTURES

HAN-PIN KAN *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 489-501 Sep. 1992

(Contract(s)/Grant(s): IRAD PROJ. R-1056)

Avail: CASI HC A03/MF A04

A probabilistic static stress analysis methodology has been developed to estimate the reliability of a composite structure. Closed form stress analysis methods are the primary analytical tools used in this methodology. These structural mechanics methods are used to identify independent variables whose variations significantly affect the performance of the structure. Once these variables are identified, scatter in their values is evaluated and statistically characterized. The scatter in applied loads and the structural parameters are then fitted to appropriate probabilistic distribution functions. Numerical integration techniques are applied to compute the structural reliability. The predicted reliability accounts for scatter due to variability in material strength, applied load, fabrication and assembly.

11 CHEMISTRY AND MATERIALS

bly processes. The influence of structural geometry and mode of failure are also considerations in the evaluation. Example problems are given to illustrate various levels of analytical complexity.

Author

N95-28443*# LTV Aerospace and Defense Co., Dallas, TX. Aircraft Div.

PROBABILISTIC DESIGN OF ADVANCED COMPOSITE STRUCTURE

P. M. GRAY and M. G. RISKALLA *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 523-533 Sep. 1992

Avail: CASI HC A03/MF A04

Advanced composite technology offers potentials for sizable improvements in many areas: weight savings, maintainability, durability, and reliability. However, there are a number of inhibitors to these improvements. One of the biggest inhibitors is the imposition of traditional metallic approaches to design of composite structure. This is especially detrimental in composites because new materials technology demands new design approaches. Of particular importance are the decisions made regarding structural criteria. Significant changes cannot be implemented without careful consideration and exploration. This new approach is to implement changes on a controlled, verifiable basis. Probabilistic design is the methodology and the process to accomplish this. Its foundation is to base design criteria and objectives on reliability targets instead of arbitrary factors carried over from metallic structural history. The background is discussed of probabilistic design and the results are presented of a side-by-side comparison to generic aircraft structure designed the 'old' way and the 'new'. Activities are also defined that need to be undertaken to evolve available approaches to probabilistic design followed by summary and recommendations.

Author

N95-28445*# Naval Postgraduate School, Monterey, CA.

PROOF TEST METHODOLOGY FOR COMPOSITES

EDWARD M. WU and DAVID K. BELL *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 549-560 Sep. 1992 Sponsored in part by DARPA

Avail: CASI HC A03/MF A04

The special requirements for proof test of composites are identified based on the underlying failure process of composites. Two proof test methods are developed to eliminate the inevitable weak fiber sites without also causing flaw clustering which weakens the post-proof-test composite. Significant reliability enhancement by these proof test methods has been experimentally demonstrated for composite strength and composite life in tension. This basic proof test methodology is relevant to the certification and acceptance of critical composite structures. It can also be applied to the manufacturing process development to achieve zero-reject for very large composite structures.

Derived from text

N95-28446*# Naval Air Development Center, Warminster, PA.

NAVY COMPOSITE MAINTENANCE AND REPAIR EXPERIENCE

T. M. DONNELLAN, R. C. COCHRAN, E. L. ROSENZWEIG, and R. E. TRABOCCO *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 1 p 565-572 Sep. 1992

Avail: CASI HC A02/MF A04

The Navy has been a strong proponent of composites for aircraft structure. Fleet use of composites started with the F-14 in the early 1970's and has steadily increased. This experience base provides sufficient information to allow an evaluation of the maintenance performance of polymer composites in service. A summary is presented of the Navy's experience with maintenance of composite structure. The general types of damage experienced in the fleet as well as specific examples of composite damage to aircraft is described. The impact of future designs on supportability is also discussed.

Author

N95-28462*# Federal Aviation Administration, Washington, DC. NINTH DOD/NASA/FAA CONFERENCE ON FIBROUS COMPOSITES IN STRUCTURAL DESIGN, VOLUME 2

JOSEPH R. SODERQUIST, comp., LAWRENCE M. NERI, comp. (Federal Aviation Administration, Atlantic City, NJ.), and HERMAN L. BOHON, comp. (Galaxy Scientific Corp., Hampton, VA.) Sep. 1992 565 p Conference held in Lake Tahoe, NV, 4-7 Nov. 1991; sponsored by NASA, AF, Army, and Navy Sponsored by NASA (NASA-CR-198722; NAS 1.26:198722; DOT/FAA/CT-92-25-VOL-2) Avail: CASI HC A24/MF A04

This publication contains the proceedings of the Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design held at Lake Tahoe, Nevada, during 4-7 Nov. 1991. Presentations were made in the following areas of composite structural design: perspectives in composites, design methodology, design applications, design criteria, supporting technology, damage tolerance, and manufacturing. For individual titles, see N95-28463 through N95-28489.

N95-28463*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

OVERVIEW OF THE ACT PROGRAM

JOHN G. DAVIS, JR. *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 577-599 Sep. 1992

Avail: CASI HC A03/MF A04

NASA's Advanced Composites Program (ACT) was initiated in 1988. A National Research Announcement was issued to solicit innovative ideas that could significantly contribute to development and demonstration of an integrated technology data base and confidence level that permits cost-effective use of composite primary structures in transport aircraft. Fifteen contracts were awarded by the Spring of 1989 and the participants include commercial and military airframe manufacturers, materials developers and suppliers, universities, and government laboratories. The program approach is to develop materials, structural mechanics methodology, design concepts, and fabrication procedures that offer the potential to make composite structures cost-effective compared to aluminum structure. Goals for the ACT program included 30-50 percent weight reduction, 20-25 percent acquisition cost reduction, and provided the scientific basis for predicting materials and structures performance. This paper provides an overview of the ACT program status, plans, and selected technical accomplishments. Sixteen additional papers, which provide more detailed information on the research and development accomplishments, are contained in this publication.

Author

N95-28464*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DESIGNERS' UNIFIED COST MODEL

W. FREEMAN, L. ILCEWICZ (Boeing Commercial Airplane Co., Seattle, WA.), G. SWANSON (Boeing Commercial Airplane Co., Seattle, WA.), and T. GUTOWSKI (Massachusetts Inst. of Tech., Cambridge, MA.) *In* FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 601-619 Sep. 1992 Previously announced as X92-10406

Avail: CASI HC A03/MF A04

The Structures Technology Program Office (STPO) at NASA LaRC has initiated development of a conceptual and preliminary designers' cost prediction model. The model will provide a technically sound method for evaluating the relative cost of different composite structural designs, fabrication processes, and assembly methods that can be compared to equivalent metallic parts or assemblies. The feasibility of developing cost prediction software in a modular form for interfacing with state-of-the-art preliminary design tools and computer aided design programs is being evaluated. The goal of this task is to establish theoretical cost functions that relate geometric design features to summed material cost and labor content in terms of process mechanics and physics. The output of the designers' present analytical tools will be input for the designers' cost prediction model to provide the designer with a database and

deterministic cost methodology that allows one to trade and synthesize designs with both cost and weight as objective functions for optimization. This paper presents the team members, approach, goals, plans, and progress to date for development of COSTADE (Cost Optimization Software for Transport Aircraft Design Evaluation). Author

N95-28466* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

COMPOSITE FUSELAGE SHELL STRUCTURES RESEARCH AT NASA LANGLEY RESEARCH CENTER

JAMES H. STARNES, JR. and MARK J. SHUART In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 631-657 Sep. 1992 Previously announced as X92-10408

Avail: CASI HC A03/MF A04

Fuselage structures for transport aircraft represent a significant percentage of both the weight and the cost of these aircraft primary structures. Composite materials offer the potential for reducing both the weight and the cost of transport fuselage structures, but only limited studies of the response and failure of composite fuselage structures have been conducted for transport aircraft. The behavior of these important primary structures must be understood, and the structural mechanics methodology for analyzing and designing these complex stiffened shell structures must be validated in the laboratory. The effects of local gradients and discontinuities on fuselage shell behavior and the effects of local damage on pressure containment must be thoroughly understood before composite fuselage structures can be used for commercial aircraft. This paper describes the research being conducted and planned at NASA LaRC to help understand the critical behavior of composite fuselage structures and to validate the structural mechanics methodology being developed for stiffened composite fuselage shell structure subjected to combined internal pressure and mechanical loads. Stiffened shell and curved stiffened panel designs are currently being developed and analyzed, and these designs will be fabricated and then tested at Langley to study critical fuselage shell behavior and to validate structural analysis and design methodology. The research includes studies of the effects of combined internal pressure and mechanical loads on nonlinear stiffened panel and shell behavior, the effects of cutouts and other gradient-producing discontinuities on composite shell response, and the effects of local damage on pressure containment and residual strength. Scaling laws are being developed that relate full-scale and subscale behavior of composite fuselage shells. Failure mechanisms are being identified and advanced designs will be developed based on what is learned from early results from the LaRC research activities. Results from combined load tests will be used to validate analytical models of critical nonlinear response mechanisms as well as shell scaling laws. Author

N95-28469* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DEVELOPMENT OF STITCHED/RTM COMPOSITE PRIMARY STRUCTURES

SUSAN M. KULLERD (Lockheed Engineering and Sciences Co., Hampton, VA.) and MARVIN B. DOW In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 689-713 Sep. 1992 Previously announced as X92-10411

Avail: CASI HC A03/MF A04

The goal of the NASA Advanced Composites Technology (ACT) Program is to provide the technology required to gain the full benefit of weight savings and performance offered by composite primary structures. Achieving the goal is dependent on developing composite materials and structures which are damage tolerant and economical to manufacture. Researchers at NASA LaRC and Douglas Aircraft Company are investigating stitching reinforcement combined with resin transfer molding (RTM) to create structures meeting the ACT program goals. The Douglas work is being performed under a NASA contract entitled Innovative Composites

Aircraft Primary Structures (ICAPS). The research is aimed at materials, processes and structural concepts for application in both transport wings and fuselages. Empirical guidelines are being established for stitching reinforcement in primary structures. New data are presented in this paper for evaluation tests of thick (90-ply) and thin (16-ply) stitched laminates, and from selection tests of RTM composite resins. Tension strength, compression strength and post-impact compression strength data are reported. Elements of a NASA LaRC program to expand the science base for stitched/RTM composites are discussed. Author (revised)

N95-28475* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

RECENT PROGRESS IN NASA LANGLEY TEXTILE REINFORCED COMPOSITES PROGRAM

H. BENSON DEXTER, CHARLES E. HARRIS, and NORMAN J. JOHNSTON In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 845-873 Sep. 1992 Previously announced as X92-10418

Avail: CASI HC A03/MF A04

The NASA LaRC is conducting and sponsoring research to explore the benefits of textile reinforced composites for civil transport aircraft primary structures. The objective of this program is to develop and demonstrate the potential of affordable textile reinforced composite materials to meet design properties and damage tolerance requirements of advanced aircraft structural concepts. In addition to in-house research, the program was recently expanded to include major participation by the aircraft industry and aerospace textile companies. The major program elements include development of textile preforms, processing science, mechanics of materials, experimental characterization of materials, and development and evaluation of textile reinforced composite structural elements and subcomponents. The NASA Langley in-house focus is as follows: development of a science-based understanding of resin transfer molding (RTM), development of powder-coated towpreg processes, analysis methodology, and development of a performance database on textile reinforced composites. The focus of the textile industry participation is on development of multidirectional, damage-tolerant preforms, and the aircraft industry participation is in the areas of design, fabrication and testing of textile reinforced composite structural elements and subcomponents. Textile processes such as 3D weaving, 2D and 3D braiding, and knitting/stitching are being compared with conventional laminated tape processes for improved damage tolerance. Through-the-thickness reinforcements offer significant damage tolerance improvements. However, these gains must be weighed against potential loss in in-plane properties such as strength and stiffness. Analytical trade studies are underway to establish design guidelines for the application of textile material forms to meet specific loading requirements. Fabrication and testing of large structural components are required to establish the full potential of textile reinforced composite materials. Author

N95-28477* Grumman Aerospace Corp., Bethpage, NY. Aircraft Systems.

COMPARISON OF RESIN FILM INFUSION, RESIN TRANSFER MOLDING, AND CONSOLIDATION OF TEXTILE PREFORMS FOR PRIMARY AIRCRAFT STRUCTURE

J. SUAREZ and S. DASTIN In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 903-934 Sep. 1992 Previously announced as X92-10420 Sponsored by NASA. Langley Research Center

Avail: CASI HC A03/MF A04

Under NASA's Novel Composites for Wing and Fuselage Applications (NCWFA) Program, Grumman is developing innovative design concepts and cost-effective fabrication processes for damage-tolerant primary structures that can perform at a design ultimate strain level of 6000 micro-inch/inch. Attention has focused on the use of textile high-performance fiber-reinforcement concepts that provide improved damage tolerance and out-of-plane load capability, low-cost resin film infusion (RFI) and resin transfer molding (RTM) processes, and thermoplastic forming concepts. The fabrica-

11 CHEMISTRY AND MATERIALS

tion of wing 'Y' spars by four different materials/processes methods is described: 'Y' spars fabricated using IM7 angle interlock 0/90 deg woven preforms with +/- 45 deg plies stitched with Toray high-strength graphite thread and processed using RFI and 3501-6 epoxy; 'Y' spars fabricated using G40-800 knitted/stitched preforms and processed using RFI and 3501-6 epoxy; 'Y' spars fabricated using G40-800 knitted/stitched7 preforms and processed using RTM and Tactix 123/H41 epoxy; and 'Y' spars fabricated using AS4(6k)/PEEK 150-g commingled angle interlock 0/90 deg woven preforms with +/- 45 deg commingled plies stitched using high-strength graphite thread and processed by consolidation. A comparison of the structural efficiency, processability, and projected acquisition cost of these representative spars is presented.

Author

N95-28478* Boeing Defense and Space Group, Philadelphia, PA.

CHARACTERIZATION AND MANUFACTURE OF BRAIDED COMPOSITES FOR LARGE COMMERCIAL AIRCRAFT STRUCTURES

MARK J. FEDRO and KURTIS WILLDEN (Boeing Commercial Airplane Co., Seattle, WA.) In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 935-978 Sep. 1992 Previously announced as X92-10421

(Contract(s)/Grant(s): NAS1-18889)

Avail: CASI HC A03/MF A04

Braided composite materials, one of the advanced material forms which is under investigation in Boeing's ATCAS program, have been recognized as a potential cost-effective material form for fuselage structural elements. Consequently, there is a strong need for more knowledge in the design, manufacture, test, and analysis of textile structural composites. The overall objective of this work is to advance braided composite technology towards applications to a large commercial transport fuselage. This paper summarizes the mechanics of materials and manufacturing demonstration results which have been obtained in order to acquire an understanding of how braided composites can be applied to a commercial fuselage. Textile composites consisting of 1D, 2D triaxial, and 3D braid patterns with thermoplastic and two RTM resin systems were investigated. The structural performance of braided composites was evaluated through an extensive mechanical test program. Analytical methods were also developed and applied to predict the following: internal fiber architectures, stiffnesses, fiber stresses, failure mechanisms, notch effects, and the entire history of failure of the braided composites specimens. The applicability of braided composites to a commercial transport fuselage was further assessed through a manufacturing demonstration. Three foot fuselage circumferential hoop frames were manufactured to demonstrate the feasibility of consistently producing high quality braided/RTM composite primary structures. The manufacturing issues (tooling requirements, processing requirements, and process/quality control) addressed during the demonstration are summarized. The manufacturing demonstration in conjunction with the mechanical test results and developed analytical methods increased the confidence in the ATCAS approach to the design, manufacture, test, and analysis of braided composites.

Author

N95-28481* National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

EFFECT OF LOW-SPEED IMPACT DAMAGE AND DAMAGE LOCATION ON BEHAVIOR OF COMPOSITE PANELS

DAWN JEGLEY In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 1013-1036 Sep. 1992 Previously announced as N92-23981

Avail: CASI HC A03/MF A04

An investigation of the effects of low-speed impact damage on the compression and tension strength of thin (less than .05 inches thick) and moderately thick (between .12 and .17 inches thick) composite specimens was conducted. Impact speeds ranged from 50 to 550 ft/sec (impact energies from .25 to 30.7 ft-lb) and impact

locations were near or away from a lateral unloaded edge. In this study, thin tension-loaded or compression-loaded specimens with only 90 deg and +/- 40 deg plies which were impacted away from the unloaded edge suffered less reduction in maximum load-carrying capability due to impact damage than the same specimens impacted near the unloaded edge. Unlike the thin laminates, failure loads of thicker compression-loaded specimens with a similar stacking sequence were independent of impact location. Failure loads of thin tension-loaded specimens with 0 deg plies were independent of impact location while failure loads of thicker compression-loaded specimens with 0 deg plies were dependent upon impact location. A finite-element analysis of strain distributions across the panel width indicated that high axial strains occur near the unloaded edges of postbuckled panels, indicating that impacts near the unloaded edge would significantly effect the behavior of postbuckled panels.

Author

N95-28483* General Dynamics Corp., Fort Worth, TX.

APPLICATIONS OF A DAMAGE TOLERANCE ANALYSIS METHODOLOGY IN AIRCRAFT DESIGN AND PRODUCTION

M. R. WOODWARD, S. D. OWENS, G. E. LAW, and L. A. MIGNERY In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 1071-1081 Sep. 1992

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Objectives of customer mandated aircraft structural integrity initiatives in design are to guide material selection, to incorporate fracture resistant concepts in the design, to utilize damage tolerance based allowables and planned inspection procedures necessary to enhance the safety and reliability of manned flight vehicles. However, validated fracture analysis tools for composite structures are needed to accomplish these objectives in a timely and economical manner. This paper briefly describes the development, validation, and application of a damage tolerance methodology for composite airframe structures. A closed-form analysis code, entitled SUBLAM was developed to predict the critical biaxial strain state necessary to cause sublaminar buckling-induced delamination extension in an impact damaged composite laminate. An embedded elliptical delamination separating a thin sublaminar from a thick parent laminate is modelled. Predicted failure strains were correlated against a variety of experimental data that included results from compression after impact coupon and element tests. An integrated analysis package was developed to predict damage tolerance based margin-of-safety (MS) using NASTRAN generated loads and element information. Damage tolerance aspects of new concepts are quickly and cost-effectively determined without the need for excessive testing.

Author

N95-28486* Rockwell International Science Center, Thousand Oaks, CA.

FUNDAMENTAL CONCEPTS IN THE SUPPRESSION OF DELAMINATION BUCKLING BY STITCHING

B. N. COX In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 1105-1110 Sep. 1992 Avail: CASI HC A02/MF A04

Elementary results are presented for the buckling of stitched, laminated composites containing delamination cracks. The stitching fibers are assumed to provide continuous, linear restoring tractions opposing the deflection of the delaminated layer adjacent to the crack. It is shown that there exists a characteristic length $a(0)$ for buckling: if the length, $2a$, of the delamination crack exceeds $2a(0)$, then, when buckling occurs, it will consist of waves of period $2a(0)$ and will usually not span the whole delamination. Simple expressions are derived for the critical buckling load and the minimum stitching density required to suppress buckling of the delaminated layer.

Author

N95-28621 Southwest Research Inst., San Antonio, TX. Belvoir Fuels and Lubricants Research Facility.

MECHANISM OF DEPOSIT FORMATION ON FUEL-WETTED HOT METAL SURFACES Interim Report, May 1989 - Dec.

1992

LEO L. STAVINOH, STEVEN R. WESTBROOK, and LONA A. MCINNIS Jan. 1995 91 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (Contract(s)/Grant(s): DAAK70-87-C-0043; DAAK70-92-C-0059) (AD-A289847; BFLRF-290) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Experiments were performed in a Single-Tube Heat Exchanger (STHE) apparatus and a Hot Liquid process meet Jet Fuel Thermal Oxidation Tester (JFTOT) ASTM D 3241 requirements. The HLPS-JFTOT heater tubes used were 1018 mild steel, 316 stainless steel (SS) 304 SS, and 304 SS tubes coated with aluminum, magnesium, gold, and copper. A low-sulfur was used to create deposits on the heater tubes at temperatures of 300 C, 340 C, and 380 C. Deposit thickness was measured by dielectric breakdown voltage and Auger ion milling. Pronounced differences between the deposit thickness measuring techniques suggested that both Auger milling rate and the dielectric strength of the deposit may be affected by deposit morphology/composition (such as metal ions that have become included in the bulk of the deposit). Carbon burnoff data were obtained as a means of judging the validity of DMD-derive deposit evaluations. ESCA data suggest that the thinnest deposit was the magnesium-coated test tube. The scanning Electron Microscope (SEM) photographs showed marked variations in the deposit morphology and the results suggested composition has a significant effect on the mechanism of deposition. DTIC

12

ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

A95-82259

HYBRID FINITE ELEMENT-MODAL ANALYSIS OF JET ENGINE INLET SCATTERING

DANIEL C. ROSS Univ of Michigan, Ann Arbor, MI, United States, JOHN L. VOLAKIS, and HRISTOS T. ANASTASSIU IEEE Transactions on Antennas and Propagation (ISSN 0018-926X) vol. 43, no. 3 March 1995 p. 277-285 refs (BTN-95-EIX95242673665) Copyright

With the goal of characterizing jet engine inlets, a hybrid finite element-modal formulation is presented for the analysis of cavities with complex terminations. The finite element method (FEM) is used to find the generalized scattering matrix for an N-port representation of the complex termination, where N is the number of traveling modes in the cavity. The cavity is assumed to be circular at the termination (engine) but the remainder of the cavity can be of arbitrary cross section. The scattered fields are obtained by tracing the fields back out of the cavity via a high frequency or modal technique with the generalized scattering matrix used in determining the fields at an aperture near the irregular cavity termination. 'Proof of concept' results are presented and several issues relating to the implementation of the FEM are addressed. Among these, a new artificial absorber is developed for terminating the FEM mesh and the suitability of edge or node based elements is examined. Author (EI)

A95-82391

RAREFIED GAS NUMERICAL WIND TUNNEL: OREX AND HOPE

KATSUHIKA KOURA National Aerospace Laboratory, Chofu, Tokyo, Japan, MIKINARI TAKAHIRA Daiko Limited, Shinjuku, Tokyo, Japan, and HIROAKI MATSUMOTO National Aerospace Laboratory, Chofu, Tokyo, Japan In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 643-648

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The 'rarefied gas numerical wind tunnel' (RGNWT) for the simulation of rarefied gas flows around three-dimensional whole flight bodies is developed to obtain aerodynamic characteristics and flowfield properties. The RGNWT employs the null-collision direct-simulation Monte Carlo (NC-DSMC) method. The molecular model for elastic and inelastic collisions is respectively taken as the variable soft sphere (VSS) model defined to be consistent with both the viscosity and diffusion coefficients of real gases and the statistical inelastic cross-section (SICS) model for molecules with discrete internal energy. The computation domain, collision cells, and data cells are universally taken as rectangular solids. The body surface is divided into triangular panels. Some results obtained using the RGNWT are presented for a two-dimensional circular cylinder and for the three-dimensional orbital reentry experiment vehicle (OREX) and H-II orbiting plane (HOPE). Author (Herner)

A95-82406

FLOW PAST A SYMMETRIC WEDGE WITH FORWARD SPLITTER PLATE

SIDDHARTHA VALLURI Indian Institute of Technology, Kanpur, India and E. RATHAKRISHNAN Indian Institute of Technology, Kanpur, India In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 735-740

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An experimental investigation of the effects of flat plates placed upstream of a symmetric wedge at zero degree angle of attack kept in air stream with velocities in the range from 7.28 m/s to 10.23 m/s has been carried out to study the drag and flow field of such combinations. The results suggest that a mechanism other than near wake manipulation exists for drag reduction and altering vortex shedding characteristics. It also demonstrates that the possible benefits in this geometry are not as significant as may have been expected from earlier studies. Also, the pattern of surface pressures on the upstream surfaces seems invariant with respect to plate length. Author (Herner)

A95-82407

THE AERODYNAMIC CHARACTERISTICS OF CUP-LIKE BODY IN SUPERSONIC FLOW

KOJU HIRAKI Institute of Space and Astronautical Science, Kanagawa, Japan, MOTOKI HINADA Institute of Space and Astronautical Science, Kanagawa, Japan, TAKASHI NAKAJIMA Institute of Space and Astronautical Science, Kanagawa, Japan, and YOSHIFUMI INATANI Institute of Space and Astronautical Science, Kanagawa, Japan In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 741-746

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We have conducted an experiment of a rigid cup-like body in the supersonic wind tunnel of the Institute of Space and Astronautical Science (ISAS) to obtain its fundamental aerodynamic characteristics in supersonic mach number regions. This rigid cup-like body has a shape of hemisphere, which has an outer diameter of 86 mm, and it has been placed by a sting with its mouth toward the supersonic free stream. In order to obtain the internal and external pressure distribution of the cup-like body, pressure sensors have been distributed in tangential and radial directions on the internal and external surfaces of the cup. The pressure sensors used in this experiment have the shape of a disc, whose diameter and thickness were approximately 6 mm and 0.6 mm, respectively. These sensors have been flush mounted on the each surface of the cup. As a result, we have observed not only the steady shock-wave pattern but also the unsteady shock-wave pattern at some test conditions. This unsteady shock pattern had an unsymmetrical shape and showed oscillation with time. We have obtained the frequency of the oscillating shock wave from the pressure data, which also had showed tremendous oscillation. In terms of pressure distribution, we have

studied the correlation between the pressure fluctuations at every two points. Based on these discussions, we have made a presumption that the tangential flow existed inside of the cup and that this inertial flow had something to do with the unsteady shock wave, and we have verified this presumption experimentally. Author (Herner)

A95-82418

NUMERICAL SIMULATION OF UNSTEADY AERODYNAMIC HEATING INDUCED BY SHOCK REFLECTIONS

SHIGERU ASO Kyushu University, Fukuoka, Japan and KENICHI OHYAMA Kyushu University, Fukuoka, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 811-816*

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Numerical simulations on unsteady shock reflections by a ramp have been conducted in order to investigate unsteady aerodynamic heating due to shock reflection processes at a higher incident shock Mach number. The two-dimensional Navier-Stokes equations with a thin layer approximation are solved numerically by a Total Variation Diminishing (TVD) scheme. The effect of mesh refinement to the calculated results is investigated carefully. The results show the smaller mesh size is necessary for calculating precise aerodynamic heating loads and capturing the fine structure of the shock reflection patterns.

Author (Herner)

A95-82419

A STUDY ON AERODYNAMIC HEATING PHENOMENA IN THREE-DIMENSIONAL SHOCK WAVE/TURBULENT BOUNDARY LAYER INTERACTION INDUCED BY SWEPTBACK SHARP FINS AT SUPERSONIC FLOW

SHIGERU ASO Kyushu University, Fukuoka, Japan, SYOZO MAEKAWA Kyushu University, Fukuoka, Japan, and SHIGEHIDE NAKAO Kyushu University, Fukuoka, Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 817-822*

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Shock wave/turbulent boundary layer interactions are the one of the classical, but still relevant problems. For the design of spaceplanes and winged vehicles, these phenomena are so unavoidable that it is necessary to explicate the phenomena clearly. In the present experiments, the shock wave/turbulent boundary layer interaction regions induced by sharp fins with a sweptback angle are investigated. Experiments are performed under the testing condition of Mach number of 4. First, surface flows are visualized by an oil flow technique, then surface pressure distributions are measured. The major objective of this study is to investigate the effect of the leading edge sweptback angle of a fin on the flow fields. The results show that the effect of sweptback angle of the leading edge are quite significant in reducing the interaction region.

Author (Herner)

A95-82641

STUDY OF HEAT TRANSFER RATES DURING QUENCHING OF A HOT TUBE UNDER MICROGRAVITY

C. J. WESTBYE Univ. of Toronto, Ontario, Canada, M. KAWAJI Univ. of Toronto, Ontario, Canada, and B. N. ANTAR Univ. of Tennessee Space Inst., Tullahoma, TN, US *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 2277-2282*

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A series of quenching experiments were performed aboard NASA's KC-135 aircraft to investigate the two-phase flow and convective boiling heat transfer phenomena which occur during rapid cooling and quenching of a hot tube under microgravity. In this paper, heat transfer aspects are discussed based on KC-135 experiments using a compact two-phase flow loop. The test section was an 11.3 mm i.d. stainless steel tube which was heated to an initial temperature between 200 C and 300 C. Freon-113 was injected into the tube at a constant rate between 10 cu cm/s and 60 cu cm/s under microgravity.

Transient temperature profiles were measured with nineteen thermocouples spotwelded on the outside surface of the tube. Compared to ground tests conducted using a horizontal configuration under similar boundary conditions, the quenching temperatures were reduced by about 30 C and the film boiling heat transfer rates prior to quench were reduced typically by 50% to 90%. These effects combined to substantially extend the length of time required to quench the tube. Nucleate boiling, occurring after the tube surface had become wetted, appeared to be unaffected by gravity level. Author (Herner)

A95-82642

EXPERIMENTAL INVESTIGATION OF FLOW-BOILING HEAT TRANSFER UNDER MICROGRAVITY

R. K. LUI Univ. of Toronto, Ontario, Canada, M. KAWAJI Univ. of Toronto, Ontario, Canada, and T. OGUSHI Mitsubishi Electric Corp., Japan *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 2283-2288* Research sponsored by Mitsubishi Electric Corp.

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An experimental apparatus has been constructed and used to investigate one-component flow-boiling heat transfer under microgravity conditions. Freon-113 was injected at a constant rate between 35 cu cm/s and 75 cu cm/s into a cylindrical stainless steel test section (L 914.4 mm, O.D. 12.5 mm, I.D. 12.0 mm). The horizontal test section was heated externally up to 30 kW/sq m by a flexible strip heater. The subcooled freon was boiled within the length of the test section to produce two-phase flow. Thermocouples attached to the outer surface of the test section measured the steady tube wall temperature profiles. The resulting two-phase flow was then condensed and cooled before being recirculated in the flow loop. Experiments under microgravity were performed aboard NASA's KC-135 aircraft. Preliminary tests have indicated satisfactory operation of the experimental apparatus. Limited data showed that gravity has a small effect on subcooled boiling heat transfer at high mass velocities ($G = 685 \text{ km/sq m.s.}$). On the other hand, heat transfer coefficients increased slightly (5%) during microgravity for lower mass velocities ($G = 468 \text{ kg/sq m.s.}$). Further experiments aboard the KC-135 are planned for June, 1992. Author (Herner)

A95-82645

EXPERIMENTAL INVESTIGATION OF COMPOSITE CHANNEL HEAT PIPE OPERATION IN MICRO-GRAVITY ENVIRONMENT

TETSUROU OGUSHI Mitsubishi Electric Corp., Hyogo, Japan, MASAOKI MURAKAMI Mitsubishi Electric Corp., Hyogo, Japan, MAKOTO KITADA Mitsubishi Electric Corp., Kanagawa, Japan, AKIRA YAO Mitsubishi Electric Corp., Kanagawa, Japan, and MASAHIRO KAWAJI Univ. of Toronto, Ontario, Canada *In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 2303-2307*

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This paper describes an experimental investigation of heat transfer performance and liquid flow in a composite channel heat pipe under microgravity conditions. In order to verify the normal liquid flow in the channel under micro-gravity, the liquid flow behavior was investigated by using a visualization model. The temperature drop in the thermal model of the heat pipe was measured under both micro-gravity and normal-gravity to verify the effectiveness of the channel operation under micro-gravity. Methanol was selected as the working fluid. From the experiment performed aboard KC-135 aircraft, it was found that the liquid puddle was generated at the bottom of the pipe under normal and hyper-gravity, but the liquid spread out to the top of the pipe through the axial and double ring channels under reduced gravity. The temperature drop in the heat pipe was also found to decrease when gravity changed to 0.01-g, which verified the normal operation of the composite channels in the heat pipe under micro-gravity conditions. Author (Herner)

A95-82679

STUDIES ON GAIN PERFORMANCE OF A COMBUSTION DRIVEN CO2 GAS DYNAMIC LASER

NOBUAKI KIRIU Univ. of Tokyo, Tokyo, Japan, YASUHIRO MIZOBUCHI Univ. of Tokyo, Tokyo, Japan, and EIJI OGURA Univ. of Tokyo, Tokyo, Japan *In International Symposium on Space Technology and Science*, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 2535-2540
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This paper presents recent studies on a combustion driven CO₂ gas dynamic laser (CO₂GDL) at the University of Tokyo. The authors have designed and constructed a CO₂ GDL facility for simulation of radiative heating of planetary entry, executed gain measurement experiments, and observed population inversion among vibrational modes of CO₂ molecules. Also, numerical studies have been made and numerical a GDL facility was composed to optimize the whole performance. Numerical simulation of aerodynamics is mainly improved and raised the level of understanding of the vibrational nonequilibrium flowfield within the nozzle of CO₂GDL and the relaxation process in the CO₂-N₂ system. Results from a numerical method are utilized for improvement of facility, especially in design of nozzle shape. Data from experiments have deviations and numerical results are not completely confirmed by comparison with experimental results. Author (Hemer)

A95-82798

MEASUREMENTS OF VORTEX PAIR INTERACTION WITH A CLEAN OR CONTAMINATED FREE SURFACE

A. HIRSA Rensselaer Polytechnic Inst, Troy, NY, United States and W. W. WILLMARTH *Journal of Fluid Mechanics* (ISSN 0022-1120) vol. 259 January 25 1994 p. 25-45 refs
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Laminar vortex pairs with small Froude number were generated by a submerged delta wing at negative angle of attack or by a pair of vertically oriented, counter-rotating flaps. The vortex pairs thus generated rise and interact with the free surface. The surface and subsurface flow field was studied using flow visualization and particle image velocimetry. Initial surface deformations, striations, are shown to be caused by stretching and interaction of cross-stream vortices near the surface. With small amounts of surface contamination, contamination fronts (producing Reynolds ridges) form on the surface and secondary vorticity, generated beneath the surface beyond the fronts, rolls up to form vortices with opposite rotation outboard of the primary vortices. The circulation associated with the secondary vortices is as much as 1/3 that of the primary vortices. The secondary vortices cause the primary vortex pair to rebound from the surface. Slight surface deformations, scars, are caused by the primary and secondary vortices. Author (EI)

A95-82905

DEVELOPMENT OF 70MW CLASS SUPERCONDUCTING GENERATORS

K. ARAI AIST (Agency of Industrial Science and Technology of MITI), Osaka City, Japan, M. KAZUMORI, T. ICHIKAWA, Y. NAKABAYASHI, S. OHSHIMA, Y. MATSUNOBU, H. SAWAZAKI, Y. YAGI, A. UEDA, and T. KITAJIMA *IEEE Transactions on Magnetics* (ISSN 0018-9464) vol. 30, no. 4 pt 2 July 1994 p. 1875-1878 *Proceedings of the 13th International Conference on Magnet Technology (MT-13)*. Part 2 (of 2), Victoria, BC, Can, Sep 20-24 1993 refs
(BTN-94-EIX95011440854) Copyright

This paper describes recent results of the Research and Development on the 70 MW class superconducting generator (hereinafter called model machine) in Super-GM, according to an 11-year period program since 1988. Author (EI)

A95-82982

SUBHARMONIC AND QUASI-PERIODIC MOTIONS OF AN ECCENTRIC SQUEEZE FILM DAMPER-MOUNTED RIGID ROTOR

J. Y. ZHAO Australian Defence Force Acad, Campbell, Australia, I. W. LINNETT, and L. J. MCLEAN *Journal of Vibration and Acoustics*,

Transactions of the ASME (ISSN 1048-9002) vol. 116, no. 3 July 1994 p. 357-363 refs

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When a squeeze-film damper is operated eccentrically, the nonlinear damper forces are no longer radially symmetric and subharmonic and quasi-periodic vibrations may be excited by the rotor unbalance. In this study, the unbalance response of a rigid rotor, supported on an eccentric squeeze film damper, is first approximated by a harmonic series whose coefficients are determined by the collocation method, together with a nonlinear least-square regression. The stability of the resulting periodic solution is then examined using the Floquet transition matrix method. For sufficiently large values of the unbalance and the damper static radial misalignment, it is shown that the approximate harmonic motion loses its stability and bifurcates into a stable subharmonic motion and a quasi-periodic motion at speeds above twice the system critical speed. This analytical finding is verified by a numerical integration in forms of the Poincare map, the rotor trajectory, the bifurcation diagram, and the power spectrum. It is suggested that stability analysis and numerical integration should always be incorporated into an approximate analytical method to achieve an adequate approximation. The results of this study show that the introduction of squeeze-film dampers may give rise to the undesirable nonsynchronous vibrations, which limits the maximum speed at which dampers should be used. Author (EI)

A95-82986

VIBRATION MEASUREMENTS ON ROTATING MACHINERY USING LASER DOPPLER VELOCIMETRY

S. J. ROTHBERG Loughborough Univ of Technology, Leicestershire, United Kingdom and N. A. HALLIWELL *Journal of Vibration and Acoustics*, *Transactions of the ASME* (ISSN 1048-9002) vol. 116, no. 3 July 1994 p. 326-331 refs
(BTN-94-EIX95011440597) Copyright

This paper explores the use of laser vibrometry for vibration measurement directly from a rotating component. The presence of a surface velocity component due to the rotation itself is shown to create a strong measurement dependency on vibration perpendicular to the intended measurement direction. Particular ambiguity results at synchronous frequencies. A mathematical means to resolve the genuine vibration components from two simultaneous laser vibrometer measurements is presented and shown to be effective in the study of nonsynchronous rotor vibrations. Author (EI)

A95-83487

MULTIPLE INSTABILITIES OF THREE-DIMENSIONAL BOUNDARY LAYERS ALONG A CONCAVE WALL

NOBUTAKE ITOH National Aerospace Laboratory, Tokyo, Japan *Fluid Dynamics Research* (ISSN 0169-5983) vol. 13, no. 2 February 1994 p. 81-95
(HTN-95-71126) Copyright

The initial stage of laminar-turbulent transition in boundary layers on a swept wing is governed by two types of instability, namely, the Tollmien-Schlichting instability based on the effect of viscosity and the cross-flow instability associated with the twisted velocity distribution of three-dimensional boundary layers. If the flow is along a locally concave surface, there is another possibility, that of Taylor-Goertler instability induced by centrifugal force. The strength of these instabilities mainly depends upon Reynolds number, magnitude and direction of the cross-flow, and local curvature of the wall. Thus a model system of linear equations is proposed to describe the initial development of disturbances through the three instabilities, and its eigensolutions are used to evaluate stability limits of the Falkner-Skan-Cooke flow to those disturbances. The three types of disturbances can be distinguished from each other by definite differences in the wavenumber and frequency regions. Three subregions in the parameter plane of cross-flow magnitude and wall curvature are determined in correspondence to the three instabilities, each of which gives the lowest value of critical Reynolds number in its own subregion. Author (Hemer)

A95-83495

ANALYSIS OF BACKSCATTERING FROM WING AND FUSELAGE JOINTS

YING-ZHENG RUAN Univ. of Electronic Science and Technology of China, Chendu, China and JUN TIAN Univ. of Electronic Science and Technology of China, Chendu, China Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 6, no. 3 August 1993 p. 205-210 (HTN-95-71134) Copyright

The dihedral reflector with wing and fuselage joint is a very strong electromagnetic scattering source in a wide angular region. The prediction of the electromagnetic scattering and radar cross section from this construction, however, is a complicated theoretical problem, because one of the dihedral surfaces is curved. In this paper, the problem is analyzed and calculated by the method of complex ray expansion combined with geometrical theory of diffraction, dealing with the specular multi-reflections and the edge diffractions respectively. The influence of the geometrical parameters of the construction, such as the angle between wing and fuselage and the radius of airframe, on the radar cross section of target is evaluated numerically. The obtained results show that the presented method is an effective approach to the radar cross section prediction, and the scattering contribution from the wing-fuselage dihedral can be reduced substantially by the computer optimization of geometrical construction. Author (Hemer)

A95-83648

OBSERVATION OF TRAVELING WAVES IN THE THREE-DIMENSIONAL BOUNDARY LAYER ALONG A YAWED CYLINDER

SHOHEI TAKAGI National Aerospace Laboratory, Chofu, Tokyo, Japan and NOBUTAKE ITOH National Aerospace Laboratory, Chofu, Tokyo, Japan Fluid Dynamics Research (ISSN 0169-5983) vol. 14, no. 4 October 1994 p. 167-189 (HTN-95-61064) Copyright

Experimental investigations are made of crossflow instability of the three-dimensional boundary layer along a yawed circular cylinder. To explore the effect of environmental disturbances on transition, comparative experiments are performed in high- and low-turbulence wind tunnels. Independent of turbulence level, unsteady disturbances with definite frequencies instead of stationary vortices are observed in hot-wire surveys of the unstable flow field. Detailed measurements with the aid of hot-wire arrays have confirmed that the unsteady disturbances are identical with the so-called crossflow traveling waves predicted by linear stability theory as the most unstable disturbances, although some discrepancies still remain between experimental results and theoretical predictions. Author (Hemer)

A95-83654

INSTABILITY OF THREE-DIMENSIONAL BOUNDARY LAYERS DUE TO STREAMLINE CURVATURE

NOBUTAKE ITOH National Aerospace Laboratory, Tokyo, Japan Fluid Dynamics Research (ISSN 0169-5983) vol. 14, no. 6 December 1994 p. 353-366 (HTN-95-61070) Copyright

Investigated are the fundamental roles of the curvature of external streamlines in the stability of three-dimensional boundary layers, the partial differential equations governing small disturbances superimposed on the basic flows are modeled by a simple system of ordinary differential equations, which include a nondimensional parameter denoting magnitude of the streamline curvature. The eigenvalue problem posed by the model equations is numerically solved to evaluate effects of this parameter on critical Reynolds numbers of the Falkner-Skan-Cooke family of three-dimensional velocity profiles. Computational results predict the possibility of a new instability, essentially due to the streamline curvature, of the centrifugal type similar to the Taylor-Gortler instability caused by a concave curvature of the wall. Author (Hemer)

A95-83857

THE DYNAMIC NATURE OF ROTOR THERMAL BENDING**DUE TO UNSTEADY LUBRICANT SHEARING WITHIN A BEARING**

P. S. KEOGH University of Bath, Bath, UK and P. G. MORTON University of Bath, Bath, UK Royal Society (London), Proceedings, Series A - Mathematical and Physical Sciences (ISSN 0962-8444) vol. 445, no. 1924 May 9, 1994 p. 273-290 (HTN-95-42091) Copyright

The influence upon the temperature distribution within a hydrodynamically lubricated journal bearing of a time varying journal orbit is considered and the oscillatory source distribution arising as a result of unsteady shearing of the lubricant is examined with respect to axes which rotate with the journal. The time dependent thermal bend induced in a rotor by such a process has been evaluated and incorporated into a rotor dynamic model for the assessment of system stability. Techniques have been developed enabling calculations to be carried out on an idealized rotor-bearing configuration and the speed range over which instability occurred was established. The rate of growth of the unstable vibrations together with the rate and direction of 'spiralling' of the thermal bend vector were also determined. Features of rotor and bearing design having an influence on such thermally induced instability are assessed.

Author (Hemer)

A95-84026

TWO-DIMENSIONAL VISCOUS FLOW PAST A FLAT PLATE

K. M. IN Korea Advanced Institute of Science and Technology, Taejeon, South Korea, D. H. CHOI Korea Advanced Institute of Science and Technology, Taejeon, South Korea, and M.-U. KIM Korea Advanced Institute of Science and Technology, Taejeon, South Korea Fluid Dynamics Research (ISSN 0169-5983) vol. 15, no. 1 January 1995 p. 13-24 Research sponsored by the Advanced Fluids Engineering Research Center (HTN-95-42210) Copyright

Using the Navier-Stokes equations of the vorticity-stream function form in body-fitted orthogonal coordinates, the flow past a flat plate at various angles of incidence has been numerically investigated for Reynolds number up to 30. By treating the singularity at the tip analytically, in that the near-tip behavior is expanded in powers of the local variables and matched to the outer finite-difference solution, the calculation procedure can be made very accurate, robust and efficient. It is shown that the singular behavior of the vorticity and pressure are well captured, and the analytic pressure distribution around the tip enables one to calculate the forces acting on the plate accurately. The results are seen to be in good agreement with those reported earlier for the flow past a normal flat plate. The flow pattern at other angles of incidence is discussed, and a detailed flow map along with the drag and lift coefficients with respect to the angle of incidence and Re is presented.

Author (Hemer)

A95-84029

FREE CONVECTION PAST A UNIFORM FLUX SURFACE INCLINED AT A SMALL ANGLE TO THE HORIZONTAL

I. POP University of Cluj, Cluj, Romania, M. KUMARI Indian Institute of Science, Bangalore, India, and G. NATH Indian Institute of Science, Bangalore, India Fluid Dynamics Research (ISSN 0169-5983) vol. 15, no. 1 January 1995 p. 57-67 (HTN-95-42213) Copyright

Free convection boundary layer over a semi-infinite flat plate with a uniform surface heat flux which is inclined at a small angle to the horizontal is discussed. When the plate is inclined at a positive angle, series solutions, one valid near the leading edge and the other at large distances from it, are obtained. Very accurate numerical results are determined by using an implicit finite-difference scheme known as Keller box method in the region where neither series is adequate. For negatively inclined plate, a series solution valid near the leading edge is again obtained and the same numerical method is employed to solve the full boundary layer equations to extend the solution downstream, past the point at which the boundary layer separates from the plate. Eigenvalues and their corresponding eigenfunctions which are associated with large distances from the

leading edge have been sought and it has been found that their contribution up to third-order correction is identically zero. Numerical results have been determined for a wide range of values of the Prandtl number Pr but the results are only presented for $Pr = 0.72$ (air). Author (Herner)

A95-84193

SECOND-LAW ANALYSIS OF VAPOR COMPRESSION HEAT PUMPS WITH SOLUTION CIRCUIT

K. AMRANE ICF Inc, Washington, DC, United States and R. RADERMACHER Journal of Engineering for Gas Turbines and Power, Transactions of the ASME (ISSN 0742-4795) vol. 116, no. 3 July 1994 p. 453-461 refs (BTN-94-EIX95011441236) Copyright

A second-law analysis is conducted on both the single-stage vapor compression heat pump with solution circuit (VCHSC) and its modified version, the cycle with a preheater and additional desorber. The results are compared to a conventional heat pump cycle operating with pure ammonia. The location and magnitude of the irreversibilities of the individual components constituting the cycles are determined. The entropic average temperature is used in computing the irreversibilities. The total work input to the heat pumps is then conveniently decomposed into two parts: the minimum work input or the work of a reversible cycle operating between the desorber and absorber entropic average temperatures, plus an additional input of work caused by the irreversibilities of the different processes of the cycles. The analysis reveals that the compressor is the most inefficient component of the heat pumps with losses accounting for about one fourth of the work input. The irreversibilities in the desorber and absorber are found to be minimum when there is a good match in both the solution and heat transfer fluid temperature glides. By adding a preheater and an additional desorber, the irreversibilities in the single-stage VCHSC are considerably reduced. However, it is shown that it is the preheater and not the additional desorber that has by far the most significant impact on the heat pump's efficiency improvements. Compared to a conventional ammonia vapor compression cycle, the modified VCHSC, which has twice as many sources of irreversibility, shows nevertheless a maximum improvement of 56.1 percent in second-law efficiency. Author (EI)

A95-84198

GETRAN: A GENERIC, MODULARLY STRUCTURED COMPUTER CODE FOR SIMULATION OF DYNAMIC BEHAVIOR OF AERO- AND POWER GENERATION GAS TURBINE ENGINES

M. T. SCHOEIRI Texas A&M Univ, College Station, TX, United States, M. ATTIA, and C. LIPKE Journal of Engineering for Gas Turbines and Power, Transactions of the ASME (ISSN 0742-4795) vol. 116, no. 3 July 1994 p. 494-483 refs (BTN-94-EIX95011441241) Copyright

The design concept, the theoretical background essential for the development of the modularly structured simulation code GETRAN, and several critical simulation cases are presented in this paper. The code being developed under contract with NASA Lewis Research Center is capable of simulating the nonlinear dynamic behavior of single- and multispool core engines, turbofan engines, and power generation gas turbine engines under adverse dynamic operating conditions. The modules implemented into GETRAN correspond to components of existing and new-generation aero- and stationary gas turbine engines with arbitrary configuration and arrangement. For precise simulation of turbine and compressor components, row-by-row diabatic and adiabatic calculation procedures are implemented that account for the specific turbine and compressor cascade, blade geometry, and characteristics. The nonlinear, dynamic behavior of the subject engine is calculated solving a number of systems of partial differential equations, which describe the unsteady behavior of each component individually. To identify each differential equation system unambiguously, special attention is paid to the addressing of each

component. The code is capable of executing the simulation procedure at four levels, which increase with the degree of complexity of the system and dynamic event. As representative simulations, four different transient cases with single- and multispool thrust and power generation engines were simulated. These transient cases vary from throttling the exit nozzle area, operation with fuel schedule, rotor speed control, to rotating stall and surge. Author (EI)

A95-84207

PRESSURE AND TEMPERATURE DISTORTION TESTING OF A TWO-STAGE CENTRIFUGAL COMPRESSOR

W. T. COUSINS Allied Signal Engines, Phoenix, AZ, United States, K. K. DALTON, T. T. ANDERSEN, and G. A. BOBULA Journal of Engineering for Gas Turbines and Power, Transactions of the ASME (ISSN 0742-4795) vol. 116, no. 3 July 1994 p. 567-573 refs (BTN-94-EIX95011441250) Copyright

Altitude pressure and temperature inlet distortion testing of the two-stage centrifugal compressor in the T800-LHT-800 engine is described. The test setup and the testing techniques are reviewed and the results of the test are presented. The generation of classical 180 deg patterns of both pressure and temperature distortion is discussed. Temperature distortion was created using a hydrogen burner system while pressure distortion was created in the classical manner, using screens. Results of both individual and combined temperature and pressure distortions in both opposed and concurrent patterns are shown. Author (EI)

A95-84211

STUDY ON THE TURBINE VANE AND BLADE FOR A 1500 C CLASS INDUSTRIAL GAS TURBINE

S. AMAGASA Tohoku Electric Power Co, Inc, Sendai, Japan, K. SHIMOMURA, M. KADOWAKI, K. TAKEISHI, H. KAWAI, S. AOKI, and K. AOYAMA Journal of Engineering for Gas Turbines and Power, Transactions of the ASME (ISSN 0742-4795) vol. 116, no. 3 July 1994 p. 597-604 refs (BTN-94-EIX95011441254) Copyright

This paper describes the summary of a three-year development program for the first-stage stationary vane and rotating blade for the next generation, 1500 C class, high-efficiency gas turbine. In such a high-temperature gas turbine, the first turbine vane and blade are the most important hot parts. Full-coverage film cooling (FCFC) is adopted for the cooling scheme, and directionally solidified (DS) nickel base superalloy and thermal barrier coating (TBC) will be used to prolong the creep and thermal fatigue life. The concept of the cooling configuration, fundamental cascade test results, and material test results will be presented. Author (EI)

A95-85027* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

STRUCTURE OF SUPERSONIC JET FLOW AND ITS RADIATED SOUND

REDA R. MANKBADI NASA. Lewis Research Center, Cleveland, OH, US, M. EHTESHAM HAYER NASA. Lewis Research Center, Cleveland, OH, US, and LOUIS A. POVINELLI NASA. Lewis Research Center, Cleveland, OH, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 5 May 1994 p. 897-906 (HTN-95-51645) Copyright

The present paper explores the use of large-eddy simulations as a tool for predicting noise from first principles. A high-order numerical scheme is used to perform large-eddy simulations of a supersonic jet flow with emphasis on capturing the time-dependent flow structure representing the sound source. The wavelike nature of this structure under random inflow disturbances is demonstrated. This wavelike structure is then enhanced by taking the inflow disturbances to be purely harmonic. Application of Lighthill's theory to calculate the far-field noise, with the sound source obtained from the calculated time-dependent near field, is demonstrated. Alternative approaches to coupling the near-field sound source to the far-field sound are discussed. Author (Herner)

A95-85028* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

COMPUTATIONAL/EXPERIMENTAL INVESTIGATION OF STAGED INJECTION INTO A MACH 2 FLOW

D. R. EKLUND National Research Council, Hampton, VA, US, D. G. FLETCHER Univ. of Virginia, Charlottesville, VA, US, R. J. HARTFIELD, JR. Univ. of Virginia, Charlottesville, VA, US, J. C. MCDANIEL Univ. of Virginia, Charlottesville, VA, US, G. B. NORTHAM NASA. Langley Research Center, Hampton, VA, US, C. L. DANCEY Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, US, and J. A. WANG Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 5 May 1994 p. 907-916
(Contract(s)/Grant(s): NAG1-373; NAG1-795; NAS1-18471)
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The stage normal injection of two jets of air into a Mach 2 freestream behind a rearward-facing step has been investigated using laser-induced iodine fluorescence and laser doppler anemometry techniques. A detailed data set has been compiled that includes profiles of pressure, temperature, two components of velocity, and mole fraction of the injectant at 44 locations, plus planar surveys of pressure, temperature, velocity, and mole fraction. A companion numerical study was performed using the SPARK Navier-Stokes code. Good overall agreement was observed for this complex, highly three-dimensional flowfield. Discrepancies were observed in the computed and measured total temperatures, turbulent mixing, and shock strengths. The effect of grid resolution was investigated by calculating solutions on grids of 60,000 points, 200,000 points, and 450,000 points. Differences in the solutions on the two finer grids were small. The effect of turbulence modeling was investigated by calculating solutions with three different algebraic models for the jet turbulence. Overall, the turbulence models were found to have the greatest effect on the numerical solutions, followed by the grid resolution and the injectant Mach number.

Author (Hemer)

A95-85029* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SCREECH TONES FROM FREE AND DUCTED SUPERSONIC JETS

C. K. W. TAM Florida State Univ., Tallahassee, FL, US, K. K. AHUJA Georgia Inst. of Tech., Atlanta, GA, US, and R. R. JONES, III Sverdrup Technology, Inc., TN, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 5 May 1994 p. 917-922
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(HTN-95-51647) Copyright

It is well known that screech tones from supersonic jets are generated by a feedback loop. The loop consists of three main components. They are the downstream propagating instability wave, the shock cell structure in the jet plume, and the feedback acoustic waves immediately outside the jet. Evidence will be presented to show that the screech frequency is largely controlled by the characteristics of the feedback acoustic waves. The feedback loop is driven by the instability wave of the jet. Thus the tone intensity and its occurrence are dictated by the characteristics of the instability wave. In this paper the dependence of the instability wave spectrum on the azimuthal mode number (axisymmetric or helical/flapping mode, etc.), the jet-to-ambient gas temperature ratio, and the jet Mach number are studied. The results of this study provide an explanation for the observed screech tone mode switch phenomenon (changing from axisymmetric to helical mode as Mach number increases) and the often-cited experimental observation that tone intensity reduces with increase in jet temperature. For ducted supersonic jets screech tones can also be generated by feedback loops formed by the coupling of normal duct modes to instability waves of the jet. The screech frequencies are dictated by the frequencies of the duct modes. Super resonance, resonance involving very large pressure oscillations, can occur when the feedback loop is powered by the most amplified instability wave. It is proposed that the observed large amplitude pressure fluctuations and tone in the test cells of Arnold Engineering Development Center were generated by super

resonance. Estimated super-resonance frequency for a Mach 1.3 axisymmetric jet tested in the facility agrees well with measurement.

Author (Hemer)

A95-85030* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

TRANSITION CORRELATIONS IN THREE-DIMENSIONAL BOUNDARY LAYERS

HELEN L. REED Arizona State Univ., Tempe, AZ, US and TIMOTHY S. HAYNES Arizona State Univ., Tempe, AZ, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 5 May 1994 p. 923-929 Research sponsored by the NSF; NASA. Ames Research Center; and Tohoku Univ., Japan
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(HTN-95-51648) Copyright

The stability and transition characteristics of three-dimensional boundary-layer flows are examined. First, the flow over a rotating cone is considered computationally. An increase of stagnation temperature is found to be only slightly stabilizing. Parameter studies on the simple rotating-cone geometry provide a large database of three-dimensional boundary-layer profiles and associated stability characteristics. To determine the possibility of correlating transition location with parameters based purely on basic-state three-dimensional boundary-layer profile characteristics, an empirical transition location of $N = 9$ is assumed. Transition location does not correlate with the traditional crossflow Reynolds number. A more appropriate definition for crossflow Reynolds number is found and termed $R(\text{sub } cf(\text{new}))$. This new parameter appears to correlate for transition location when plotted against maximum crossflow velocity. Then, the flow over a yawed cone is considered experimentally. The correlation results obtained from the rotating-cone work are applied to the actual measured transition locations on two different yawed-cone models under various angle-of-attack conditions in two different experimental facilities and are verified. This correlation is only suggested as a tool for preliminary transition prediction and design in three-dimensional boundary layers; once a preliminary shape is selected, further linear stability theory or parabolized stability equation calculations are strongly urged. Author (Hemer)

A95-85042

REATTACHMENT STUDIES OF AN OSCILLATING AIRFOIL DYNAMIC STALL FLOWFIELD

S. AHMED MCAT Inst., San Jose, CA, US and M. S. CHANDRASEKHARA Naval Postgraduate School, Monterey, CA, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 5 May 1994 p. 1006-1012
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The reattaching flow over an oscillating airfoil executing large-amplitude sinusoidal motion around a mean angle of attack of 10 deg has been studied using the techniques of stroboscopic schlieren, two-component laser Doppler velocimetry, and point diffraction interferometry, for a freestream Mach number of 0.3 and a reduced frequency of 0.05. The results show that the dynamically stalled flow reattaches in a process that begins when the airfoil is very close to the static stall angle on its downward strokes and progresses over the airfoil through a large range of angles of attack as the airfoil angle decreases to about 6 deg. The airfoil suction peak shows a dramatic rise as the static stall angle is approached, and the velocity profiles develop such that flow near the surface is accelerated. The process completes through the disappearance of a separation bubble that forms over the airfoil.

Author (Hemer)

A95-85046

CROSSFLOW TOPOLOGY OF VORTICAL FLOWS

MIGUEL R. VISBAL Wright-Patterson Air Force Base, OH, US and RAYMOND E. GORDNIER Wright-Patterson Air Force Base, OH, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 5 May 1994 p. 1085-1087
(HTN-95-51664) Copyright

Flows past delta wings and slender bodies of revolution at

angle of attack are of obvious importance in aerodynamics. These flows are characterized by the formation of streamwise vortical structures on the leeside of the body. In experimental as well as computational studies, the vortical flow structure is often examined on transverse planes normal to the body axis. On such planes, the projected or sectional streamline pattern typically exhibits crossflow separation. The purpose of this Note is to demonstrate using critical-point theory and computational results for delta wing flows that a number of distinct topologies of crossflow separation are possible. In addition, the present results confirm and extend recent experimental findings for the instantaneous crossflow topology on pitching delta wings.

Author (Hemer)

A95-85048

PRECISION REQUIREMENT FOR POTENTIAL-BASED PANEL METHODS

JAMES K. NATHMAN Analytical Methods Inc., Redmond, WA, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 5 May 1994 p. 1089-1090 (HTN-95-51666) Copyright

Morino and Kuo (1974) obtained good numerical results from a potential-based panel method for very thin wings ($t/c = 0.1\%$) but small panel number (N less than 14) while recognizing their matrix equation was nearly singular. Katz and Plotkin (1991) and Yon et al. (1992) experienced numerical difficulties from a similar approach when they analyzed airfoils with large panel number (N greater than 40) and trailing-edge angles less than 0.25 rad. The diverse behavior described in Morino and Kuo (1974) and Yon et al. (1992) can be explained by the precision of the method. Specifically, the errors in lift and trailing-edge loading observed in Yon et al. (1992) can be reduced by a factor of 100 by replacing the constant 0.15916 with a more exact representation of $1/2(\pi)$. Various aspects of the error analysis are discussed.

Hemer

A95-85050* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

PRACTICAL FORMULATION OF A POSITIVELY CONSERVATIVE SCHEME

SHIGERU OBAYASHI NASA. Ames Research Center, Moffett Field, CA, US and YASUHIRO WADA NASA. Lewis Research Center, Cleveland, OH, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 5 May 1994 p. 1093-1095 (Contract(s)/Grant(s): NCC2-605) (HTN-95-51668) Copyright

Approximate Riemann solvers have been highly successful for computing the Euler/Navier-Stokes equations, but linearized Riemann solvers are known to fail occasionally by predicting non-physical states with negative density or internal energy. Positively conservative schemes, in contrast, guarantee physical solutions from realistic input. The Harten-Lax-van Leer-Einfeldt (HLLC) scheme is a typical example of a positively conservative scheme. However, the HLLC scheme is highly dissipative at contact discontinuities and shear layers and thus it is not applicable to practice simulations. An existing modification to the HLLC scheme, known as HLLC-M, enhances the resolution to that of the Roe scheme. However, this modification violates the positivity of density and internal energy. Precise derivation of the modification yields a quadratic inequality and thus requires a case-by-case treatment. This Note describes a new, modified HLLC scheme that satisfies the positivity conservative condition approximately. Sample computations are included to demonstrate the resolution and the robustness of the scheme.

Author (Hemer)

A95-85051

NUMERICAL INVESTIGATION OF CYLINDER WAKE FLOW WITH A REAR STAGNATION JET

J. D. MO Memphis State Univ., Memphis, TN, US and M. R. DUKE, JR. Memphis State Univ., Memphis, TN, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 5 May 1994 p. 1095-1098 (HTN-95-51669) Copyright

Upon visualization of the flow past a cylinder with a rear

stagnation jet (RSJ), the flow appears fully attached as conventional inviscid flow does. Therefore, at first glance, it would be suspected that the form drag on the cylinder has been reduced to zero as predicted by inviscid flow theory. However, a detailed numerical simulation reveals that the form drag coefficient increases as the jet velocity increases. The mechanics of the increasing form drag are addressed. The following conclusions were drawn: (1) flow behind a cylinder can be effectively influenced by a RSJ; (2) the unsymmetric wake flow becomes symmetric when the RSJ is in operation with a velocity ratio as low as 1; the size of the symmetric recirculation region becomes smaller as the jet speed increases; (3) a RSJ forces a symmetrical wake flow pattern, thus eliminating the lateral force; (4) the pressure on the cylinder surface decreases over the entire surface, but significantly more on the downstream side of the cylinder, as the jet velocity increases, causing an increase in form drag as jet velocity ratio increases; and (5) the RSJ to significantly increase form drag on a bluff body has direct applications in aerodynamic controls of reentry or flights at high angles of attack.

Hemer

A95-85052

SURFACE INTERFERENCE IN RAYLEIGH SCATTERING MEASUREMENTS NEAR FOREBODIES

ZAIDI B. ZAKARIA Purdue Univ., West Lafayette, IN, US and STEVEN H. COLLICOTT Purdue Univ., West Lafayette, IN, US AIAA Journal (ISSN 0001-1452) vol. 32, no. 5 May 1994 p. 1098-1100

(HTN-95-51670) Copyright

High-speed boundary-layer transition on forebodies is currently a topic of considerable interest. Transition experiments in quiet-flow supersonic facilities require nonintrusive diagnostics. Some form of Rayleigh scattering measurement is desirable in these flows because calibrated hot-wire measurements are elusive. Rayleigh scattering measurements of density are feasible in various fluid flow experiments. Direct Rayleigh scattering is known to be infeasible near surfaces. The closest proximity for use of direct Rayleigh scattering near representative aerodynamic forebodies is determined. The purpose of the experiment is to provide data that will serve as guidelines for selection of nonintrusive diagnostic methods for experiments in high-speed forebody flows. The data presented quantify the near-body limits of the simplest form of Rayleigh scattering measurements. This experiment uses typical geometry and length scales for forebody flows in small supersonic tunnels.

Hemer

A95-85061

EXPLICIT KUTTA CONDITION FOR AN UNSTEADY TWO-DIMENSIONAL CONSTANT POTENTIAL PANEL METHOD

NEIL BOSE Memorial Univ. of Newfoundland, Newfoundland, Canada AIAA Journal (ISSN 0001-1452) vol. 32, no. 5 May 1994 p. 1078-1080 Research sponsored by the NSERC of Canada (HTN-95-51679) Copyright

Experimentalists differ in their conclusions for the boundaries of validity of a Kutta condition applied at the trailing edge of oscillating airfoils. However, in numerical work it is recognized that a Kutta condition should be applied at least for oscillations of low reduced frequency and where the angle of attack of the airfoil is not sufficient to cause trailing-edge separation. Here, an explicit Kutta condition is described that was implemented in a time-domain constant potential panel method for two-dimensional airfoils in unsteady motion. The panel method was written to calculate thrust an propulsive efficiency from oscillating hydrofoils with chordwise flexibility.

Author (Hemer)

A95-85290

THERMO-HYDRODYNAMIC SOLUTION OF FLOATING RING SEALS FOR HIGH PRESSURE COMPRESSORS USING THE FINITE-ELEMENT METHOD

S. K. BAHETI Virginia Polytechnic Institute and State University, Blacksburg, VA, US and R. G. KIRK Virginia Polytechnic Institute and State University, Blacksburg, VA, US STLE Tribology Transactions (ISSN 0569-8197) vol. 37, no. 2 April 1994 p. 336-346 (HTN-95-92246) Copyright

This paper describes the finite-element solution of the nonlinear and coupled hydrodynamic and thermal equations for pressure and temperature profiles in an oil seal including misalignment. Fluid properties are evaluated at the center of each element. For centered seals, results obtained are in good agreement with previous finite-difference analysis with approximate temperature distribution. For eccentric or axially tapered seals, use of the true temperature profile gives significantly different results. This analysis shows that the circumferential temperature variation should be considered in oil seal analysis and that reducing clearance taper produces a stabilizing effect.

Author (Herner)

A95-85291

EFFECT OF SQUEEZE FILM DAMPER LAND GEOMETRY ON DAMPER PERFORMANCE

Y. H. WANG University of New South Wales, Sydney, Australia and E. J. HAHN University of New South Wales, Sydney, Australia
STLE Tribology Transactions (ISSN 0569-8197) vol. 37, no. 2 April 1994 p. 347-357 Research sponsored by the Australian Research Council
(HTN-95-92247) Copyright

Variable axial land geometry dampers can significantly alter the unbalance response, and in particular, the likelihood of undesirable jump behavior, or circular orbit-type squeeze film dampers. Assuming end feed, the pressure distribution, the fluid film forces, and the stiffness and damping coefficients are obtained for such variable axial and geometry dampers, as well as the jump-up propensity for vertical squeeze film damped rigid rotors. It is shown that variable land geometry dampers can reduce the variation of stiffness and damping coefficients, thereby reducing the degree of damper force non-linearity, and presumably reducing the likelihood of undesirable bistable operation. However, it is also found that regardless of unbalance and regardless of the depth, width or shape of the profile, parallel land dampers are least likely to experience jump-up to undesirable operation modes. These conflicting conclusions may be accounted for by the reduction in damping. They will need to be qualified for practical dampers which normally have oil hole feed rather than end feed.

Author (Herner)

A95-85299

THE EFFECTS OF WALL PERTURBATIONS ON THERMO-TURBULENT COUETTE FLOW

RALPH A. BURTON Burton Technologies Inc., Raleigh, NC, US
STLE Tribology Transactions (ISSN 0569-8197) vol. 37, no. 2 April 1994 p. 415-419
(HTN-95-92255) Copyright

Dissipative heating in turbulent flow can be expressed in terms of a dimensionless friction coefficient $C_{(sub f)}$ which is itself determined by wall roughness and local Reynolds number and is sensitive to viscosity changes. For a short-bearing flow with a sinusoidal film thickness perturbation, viscous heating is related to film thickness in a simple way. Perturbations in temperature and viscosity are included in the analysis, which predicts the partitioning of the heat-perturbation to the wavy and smooth surfaces. Convection is discussed and shown to be less influential than in laminar flow.

Author (Herner)

A95-85305

BOUNDARY LAYER STUDIES OVER AN S-BLADE

R. S. MADHUSUDAN Indian Institute of Technology, Madras, India, P. A. ASWATHA NARAYANA Indian Institute of Technology, Madras, India, V. BALABASKARAN Indian Institute of Technology, Madras, India, and E. G. TULAPURKARA Indian Institute of Technology, Madras, India Fluid Dynamics Research (ISSN 0169-5983) vol. 14, no. 5 November 1994 p. 241-258
(HTN-95-92261) Copyright

Double cambered S-blades find applications in turbines and pumps used in tidal power plants and textile machinery. Measurement of aerodynamic characteristics like lift, drag, and lift/drag have been reported by other investigators. To gain a better understanding of the flow over such blades, the velocity profiles and turbulence

quantities have been measured on the upper and lower surfaces and are reported in this paper. The flow over the upper surface is subjected to convex curvature first and then to concave curvature, whereas flow on the lower surface encounters the concave surface first and convex later. Small regions of separated flow exist at zero degree angle of attack. The results are compared with those investigation in which the effects of pressure gradient, curvature, flow separation, and reattachment were studied separately. It is found that for the first half on both surfaces the variation of skin friction coefficient and shape parameter are dominated by the influence of surface curvature. In the last quarter the curvature and pressure gradient have cumulative effect on these parameters. In the third quarter no clear trend is seen as the curvature changes from convex to concave on the upper surface and from concave to convex on the lower surface.

Author (Herner)

A95-85466

INTERACTION OF JET NOISE WITH A NEARBY PANEL ASSEMBLY

J. L. MCGREEVY Philadelphia Coll of Pharmacy and Science, Philadelphia, PA, United States, A. BAYLISS, and L. MAESTRELLO AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 577-585 refs
(BTN-95-EIX95262694295) Copyright

A model of the interaction of the noise from a spreading subsonic jet with a panel-stringer assembly is studied numerically in two dimensions. The radiation resulting from this flow/acoustic/structure coupling is computed and analyzed in both the time and frequency domains. The jet is initially excited by a pulse-like source inserted into the flowfield. The pulse triggers instabilities associated with the inviscid instability of the jet mean flow shear layer. These instabilities in turn generate sound which provides the primary loading for the panels. The resulting structural vibration and radiation depends strongly on panel placement relative to the jet/nozzle configuration. Results are obtained for the panel responses as well as the transmitted and incident pressure. The effect of the panels is to act as a narrow filter, converting the relatively broadband forcing, heavily influenced by jet instabilities, into radiation concentrated in narrow spectral bands.

Author (EI)

A95-85469

FORCE AND MOMENT ON A JOUKOWSKI PROFILE IN THE PRESENCE OF POINT VORTICES

K. STREITLIEN Levich Inst, New York, NY, United States and M. S. TRIANTAFYLLOU AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 603-610 refs
(BTN-95-EIX95262694298) Copyright

We present closed-form expressions for the force and moment on a Joukowski profile in arbitrary motion, surrounded by point vortices that are free to convect with the local flow. Thus, rapid and accurate calculation of force and moment in ideal flow simulations is facilitated.

Author (EI)

A95-85470

PREDICTION OF TWO-DIMENSIONAL MOMENTUMLESS WAKE BY K- EPSILON - GAMMA MODEL

JONG WOO AHN Korea Research Inst of Ships and Ocean Engineering, Taejon, Korea, Republic of and HYUNG JIN SUNG AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 611-617 refs
(BTN-95-EIX95262694299) Copyright

The k-epsilon-gamma model performance is extended to resolve the jet/wake anomaly, which is encountered in calculating free shear flows by the standard k-epsilon model. In the k-epsilon-gamma model, the relation between the rate of dissipation epsilon and the level of intermittency gamma is well incorporated. The model is run to predict the two-dimensional momentumless wake where a jet and a wake coexist. The predictions of the k-epsilon-gamma model are compared with those of the k-epsilon model as well as the experiment. It is shown that the model performance is generally satisfactory.

Author (EI)

A95-85474

DYNAMIC UNSTRUCTURED METHOD FOR FLOWS PAST MULTIPLE OBJECTS IN RELATIVE MOTION

KAMAKHYA P. SINGH Old Dominion Univ, Norfolk, VA, United States, JAMES C. NEWMAN, and OKTAY BAYSAL AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 641-649 refs (BTN-95-EIX95262694303) Copyright

A new methodology is developed to simulate unsteady flows about objects in relative motion and compute the trajectory of their motion as determined by this flowfield. The method couples the fluid dynamics and rigid-body dynamics equations to capture the time-dependent interference between stationary and moving boundaries. The unsteady, compressible, inviscid (Euler) equations are solved on dynamic unstructured grids by an explicit, finite-volume, upwind method. For efficiency, the grid adaptation is performed within a window around the moving object. The Eulerian equations of the rigid-body dynamics are solved by a Runge-Kutta method in a noninertial frame of reference. This dynamic, unstructured flow solver is validated by computing the flow past a sinusoidally pitching airfoil and comparing these results with the experimental data. The trajectory code is tested by computing the six-degree-of-freedom trajectory of a store separating from a wing using the experimentally determined force and moment fields, then comparing with the experimental trajectory. Finally, the overall methodology is used for two two-dimensional examples: the flow past a pitching and plunging airfoil, and the free fall of a store after separation from a wing section.

Author (EI)

A95-85483

STABILITY OF VISCOELASTIC PLATE IN SUPERSONIC FLOW UNDER RANDOM LOADING

VADIM D. POTAPOV Moscow State Univ of Means of Communication, Moscow, Russia AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 712-715 refs (BTN-95-EIX95262694312) Copyright

The stability of a viscoelastic plate, subjected to a random load, in a supersonic flow is investigated. The stationary load is assumed in the form of Gaussian white noise. The relaxation kernel of the plate material is represented by a sum of exponents. The influence of such parameters as external damping, material viscosity, flow speed, and probabilistic characteristics of the load on the stability of the plate, in mean square form, is analyzed.

Author (EI)

A95-85485

TORSIONAL ACTUATION WITH EXTENSION-TORSION COMPOSITE COUPLING AND A MAGNETOSTRICTIVE ACTUATOR

CHRISTOPHER M. BOTHWELL Univ of Maryland, College Park, MD, United States, RAMESH CHANDRA, andINDERJIT CHOPRA AIAA Journal (ISSN 0001-1452) vol. 33, no. 4 April 1995 p. 723-729 refs (BTN-95-EIX95262694314) Copyright

An analytical-experimental study of using magnetostrictive actuators in conjunction with an extension-torsion coupled composite tube to actuate a rotor blade trailing-edge flap to actively control helicopter vibration is presented. Thin walled beam analysis based on Vlasov theory was used to predict the induced twist and extension in a composite tube with magnetostrictive actuation. The study achieved good correlation between theory and experiment. The Kevlar-epoxy systems showed good correlation between measured and predicted twist values.

EI

A95-85519

EQUIVALENT BEAM-COLUMN ANALYSIS OF GUYED TOWERS

N. BEN KAHLA Univ of Wisconsin-Madison, Madison, WI, United States Computers and Structures (ISSN 0045-7949) vol. 55, no. 4 May 17 1995 p. 631-645 refs (BTN-95-EIX95262696644) Copyright

The approximate analysis of guyed towers, in which the mast is modeled by an equivalent beam-column, is described. Equivalent

beam-column properties are presented for several triangular cross-section mast built-up patterns. The coupling between different degrees of freedom is acknowledged in the form of a geometric coupling matrix. The use of the Morison assumptions to consider wind loads on the mast is validated, and equivalent wind areas per unit length are derived. A back-substitution scheme to determine the forces in each element of the mast is developed. A comparative analysis of the approximate method and the space truss model is illustrated through an example tower.

Author (EI)

A95-86603

CONVECTION HEAT TRANSFER DISTRIBUTIONS OVER PLATES WITH SQUARE RIBS FROM INFRARED THERMOGRAPHY MEASUREMENTS

D. A. ALIAGA University of Texas, Austin, TX, US, J. P. LAMB University of Texas, Austin, TX, US, and D. E. KLEIN University of Texas, Austin, TX, US International Journal of Heat and Mass Transfer (ISSN 0017-9310) vol. 37, no. 3 February 1995 p. 363-374

(HTN-95-20713) Copyright

Heat transfer measurements were performed on two ribbed plates, with constant heat flux surfaces, using an infrared (IR) thermography technique. The test were conducted in a turbulent flow wind tunnel (0.5 X 10(exp 6) is less than Re is less than 1.5 X 10(exp 6)) at two roughness heights (e/D (sub h) = 0.052 and 0.093). The transverse ribs on the plates had a square cross section. The experimental technique provided local variations of heat transfer coefficients not only between ribs but also surrounding the ribs, with better resolution than techniques currently used. The results suggested a separation-reattachment flow distribution over the plate with a pitch ratio (p/e) of 12 and a trapped vortex flow between ribs for a p/e of 5.

Author (Hemar)

A95-86621

CONSTANT FLUX, TURBULENT CONVECTION DATA USING INFRARED IMAGING

A. H. W. LEE University of Texas at Austin, Austin, TX, US, D. E. KLEIN University of Texas at Austin, Austin, TX, US, and J. P. LAMB University of Texas at Austin, Austin, TX, US International Journal of Heat and Mass Transfer (ISSN 0017-9310) vol. 37, no. 3 February 1995 p. 535-539

(HTN-95-20731) Copyright

This paper describes a recent study which obtained convection data using an IR imaging system in flow past a smooth surface. Since this study was carried out as an initial step in obtaining data for flow past roughened surfaces friction factors were also determined. The project included the design and the construction of a smooth test surface capable of providing uniform heat flux using electrically heated foils. Experimental data included surface temperature variation, pressure gradients, and mean velocity profiles. The data were analyzed and compared with numerical solutions.

Author (Hemar)

N95-26349 Naval Research Lab., Washington, DC.

SPEECH ANALYSIS AND SYNTHESIS BASED ON PITCH-SYNCHRONOUS SEGMENTATION OF THE SPEECH

WAVEFORM Report, 1 Oct. 1992 - 30 Sep. 1993

GEORGE S. KANG and LAWRENCE J. FRANSEN 9 Nov. 1994 55 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(AD-A288824; NRL/FR/5550-94-9743) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This report describes a new speech analysis/synthesis method. This new technique does not attempt to model the human speech production mechanism. Instead, we represent the speech waveform directly in terms of the speech waveform defined in a pitch period. A significant merit of this approach is the complete elimination of pitch interference because each pitch-synchronously segmented waveform does not include a waveform discontinuity. One application of this new speech analysis/synthesis method is the alteration of speech characteristics directly on raw speech. With the increased use of man-made speech in tactical voice message systems and virtual reality environments, such a speech generation tool is highly

12 ENGINEERING

desirable. Another application is speech encoding operation at low data rates (2400 b/s or less). According to speech intelligibility tests, our new 2400 b/s encoder outperforms the current 2400-b/s LPC. This is also true in noisy environments. Because most tactical platforms are noisy (e.g., helicopter, high-performance aircraft, tank, destroyer), our 2400-b/s speech encoding technique will make tactical voice communication more effective; it will become an indispensable capability for future C4I. DTIC

N95-26405 New York Univ., New York, NY. Inst. of Mathematical Sciences.

COMPUTATIONAL FLUID DYNAMICS AND TRANSONIC

FLOW Final Technical Report, 1 Oct. 1990 - 30 Sep. 1994

PAUL R. GARABEDIAN 31 Oct. 1994 6 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): AF-AFOSR-0042-91)

(AD-A288962; AFOSR-94-0760TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The project was concerned with the development of high performance computer codes for problems in transonic aerodynamics. A practical rule to calculate the wave drag for solutions of the Euler equations was developed from an entropy equality. Symmetric shockless airfoils were analyzed for which uniqueness fails in the transonic case not just for potential flow, but also for the Euler equations. DTIC

N95-26418 Wright Lab., Wright-Patterson AFB, OH.

A NON-ITERATIVE GRID DEFORMATION ALGORITHM FOR COMPUTATIONAL FLUID DYNAMICS FOR

AEROELASTICITY Interim Report, Jun. - Jul. 1994

RICHARD D. SYNDER Sep. 1994 25 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): AF PROJ. 2401)

(AD-A288298; WL-TM-94-3130) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This Technical Memorandum presents an algorithm for deforming a two- or three-dimensional aerodynamic grid given deflections on a physical boundary. This algorithm is to be used in coupling a computational fluid dynamics code with a computational structural mechanics code. The deformation algorithm was tested successfully on both two- and three-dimensional grids. The method sufficiently maintains grid quality for smooth deflections of realistic orders of magnitude. The method is computationally efficient: the time required to deform the grid is small compared to the time required to solve the fluid dynamics. DTIC

N95-26445# Iowa State Univ. of Science and Technology, Ames, IA.

A FIXED TIME PERFORMANCE EVALUATION OF PARALLEL CFD APPLICATIONS

A. M. BAKER and S. X. YING (Ames Lab., IA.) 1994 14 p Presented at the Supercomputing '94 Meeting, Washington, DC, 14-18 Nov. 1994

(Contract(s)/Grant(s): W-7405-ENG-82)

(DE94-014240; IS-M-790; CONF-941118-3) Avail: CASI HC A03/MF A01

The inviscid gas dynamics equations have been solved on the nCUBE 2s computer to better understand the challenges and opportunities that parallel processing presents. Two basic computational fluid dynamics applications problems representing different flow physics are used as test cases. The first problem involves a supersonic flow inside a channel with a ramp surface. This internal flow problem is dominated by large gradients due to shock waves reflected between channel walls. The equations solved are coupled nonlinear hyperbolic partial differential equations. The second problem is an external flow over airfoil. The flow is subsonic, resulting in a set of elliptic pdes. Analysis of the parallel performance for these applications is presented following a fixed time measurement approach. The results from this study demonstrate that even though

these flow simulation problems are communication intensive, they are scalable. This is true even if subdomain communication includes non-nearest neighbors. Parallel computing is shown to be an effective tool for future CFD challenges. DOE

N95-26589*# MCAT Inst., San Jose, CA.

NUMERICAL SIMULATION OF THE SOFIA FLOW FIELD

Final Report

STEPHEN P. KLOTZ Jan. 1995 99 p

(Contract(s)/Grant(s): NCC2-636)

(NASA-CR-197757; NAS 1.26:197757; MCAT-95-08) Avail: CASI HC A05/MF A02

This report provides a concise summary of the contribution of computational fluid dynamics (CFD) to the SOFIA (Stratospheric Observatory for Infrared Astronomy) project at NASA Ames and presents results obtained from closed- and open-cavity SOFIA simulations. The aircraft platform is a Boeing 747SP and these are the first SOFIA simulations run with the aircraft empennage included in the geometry database. In the open-cavity runs the telescope is mounted behind the wings. Results suggest that the cavity markedly influences the mean pressure distribution on empennage surfaces and that 110-140 decibel (db) sound pressure levels are typical in the cavity and on the horizontal and vertical stabilizers. A strong source of sound was found to exist on the rim of the open telescope cavity. The presence of this source suggests that additional design work needs to be performed in order to minimize the sound emanating from that location. A fluid dynamic analysis of the engine plumes is also contained in this report. The analysis was part of an effort to quantify the degradation of telescope performance resulting from the proximity of the port engine exhaust plumes to the open telescope bay. Author

N95-26722 Naval Postgraduate School, Monterey, CA.

AIR CUSHIONED LANDING CRAFT (LCAC) BASED SHIP TO SHORE MOVEMENT SIMULATION: A DECISION AID FOR THE AMPHIBIOUS COMMANDER. A (SMMAT)

APPLICATION M.S. Thesis

EDWARD P. KEARNS, III Sep. 1994 44 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(AD-A289635) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Amphibious forces are the enabling force of choice to globally project rapid and sustainable combat power in the littoral. Whether delivering supplies and equipment for military operations or for humanitarian or disaster relief, the air cushioned landing craft (LCAC) is the primary surface ship-to-shore movement craft. The time needed to transfer the forces ashore may be critical to operational success and is an important planning consideration. Many factors complicate accurate prediction of this time. Even so, various commanders must use the best available information, given mission priorities and resource and capability limitations, to make numerous tradeoff decisions in planning and executing the movement of forces. A simulation toolbox, the simulated mobility modeling and analysis toolbox (SMMAT), is introduced, and a robust LCAC ship-to-shore simulation model is developed as an extension to SMMAT. This model provides the commander a prediction and tradeoff analysis tool for planning and executing the projection of power ashore. DTIC

N95-26739# Tokyo Univ., Sagami-hara (Japan). Inst. of Space and Astronautical Science.

VISCOUS SHOCK-LAYER ANALYSIS ON HYPERSONIC FLOW OVER REENTRY CAPSULE WITH NONEQUILIBRIUM CHEMISTRY

KOJIRO SUZUKI and TAKASHI ABE Dec. 1994 20 p Repr. from Institute of Space and Astronautical Science Report No. 656 (Sagami-hara, Japan, Tokyo Univ.), Dec. 1994 p 1-17 (ISSN 0285-6808)

(ISAS-656) Avail: CASI HC A03/MF A01

The aerothermodynamic environment around a 'EXPRESS'

reentry capsule at hypersonic speed is studied in the flight regime of the severe wall heating rate with emphasis on the effects of the wall catalyticity and temperature by using the axisymmetric viscous shock-layer equations with the seven-air-species nonequilibrium chemistry. The wall heating rate and the electron number density in the shock-layer over the capsule are predicted at various altitudes on its flight trajectory. In order to evaluate the wall catalyticity, the finite catalytic wall model is introduced. The sensitivity of the wall heating rate to the uncertainties in the chemical reaction model and the wall condition model is investigated parametrically. The extent of the influences of the wall conditions on the shock-layer flow properties strongly depends on the extent of flow nonequilibrium.

Author

N95-26751 New Mexico State Univ., Las Cruces, NM. Dept. of Mechanical Engineering.

DEMONSTRATION STUDY OF HIERARCHICAL CONTROL OF FLUID-DYNAMIC PHENOMENA Final Report

GREGORY A. REYNOLDS and EDWARD HENSEL 20 Dec. 1994 25 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (Contract(s)/Grant(s): N00014-89-J-3018) (AD-A289341) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This document is a final report for ONR grant N00014-89-J-3018, 'Demonstration Study of Hierarchical Control of Fluid-Dynamic Phenomena.' Our overall objective was to develop a laboratory experiment wherein the performance of a fluid dynamic process would be effectively controlled using a model-based system controller. We considered, as a sample fluid-dynamic process, the flow over a high-lift circulation-control wing. The essence of our model-based approach was a progression of fluid-dynamic models corresponding to the expected range of complexity in the attached and separated flow of the experiment. Development of the demonstration involved both fabrication and testing of the high-lift wing model and test apparatus, as well as coding and evaluation of the control algorithms and fluid-dynamic models. preparatory to this development, a flow facility in which to conduct the experiments had to be designed and constructed. Unfortunately, due to delays in completion of this facility, the demonstration experiments could not be carried out within the budget of the grant. Our overall objective was therefore not met, however, we will report here on the substantial progress we did make to establish the capabilities cited above.

DTIC

N95-26877 Air Force Inst. of Tech., Wright-Patterson AFB, OH. **CLASSIFICATION OF ULTRA HIGH RANGE RESOLUTION RADAR USING DECISION BOUNDARY ANALYSIS M.S. Thesis**

CHRISTOPHER L. EISENBIES Dec. 1994 122 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A289378; AFIT/GE/ENG/94D-07) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This thesis examines the discrimination of targets with Ultra High Range Resolution (UHRR) radar data. Using these measured signals from frontal aspect angles of four aircraft classes, the baseline performance of the Adaptive Gaussian Classifier (AGC) is tested with respect to aligning exemplars to templates. Alignment plays a crucial role in the AGC's classification performance which can degrade by 11% for a target class. The AGC is compared to non-parametric classifiers, but no statistically significant degradation of performance is found. Data separability is analyzed by bounding the Bayes error. The data is well separated in a statistical sense. A feature selection algorithm based on analysis of the decision boundary, is applied to find a reduced feature set, which are linear combinations of the original features. These features are optimized with respect to classification error rather than reconstruction error. This technique is extended to deduce the relevant features in the original feature space. Fewer than 5% of the features in the original feature space may be used to attain an improved classification rate. This new method is a true reduction of features and shows improvement up to 15%. Discrimination of UHRR radar signatures using a multiresolution analysis is proposed. The decision boundary

analysis chooses relevant wavelet scales with respect to classification. Some improved performance against an entropy based measure is observed for limited feature sets. The technique developed here successfully chooses the scale that causes classification performance to peak within 5% of the performance in the full-dimensional or reduced-dimensional UHRR radar signature space.

DTIC

N95-26890* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

DYNAMICALLY TIMED ELECTRIC MOTOR Patent Application

ANN M. CASPER, inventor (to NASA) (United Technologies Corp., Huntsville, AL.) 29 Dec. 1994 12 p (Contract(s)/Grant(s): NAS8-50000) (NASA-CASE-MFS-28958-1; NAS 1.71:MFS-28958-1; US-PATENT-APPL-SN-365880) Avail: CASI HC A03/MF A01

The invention disclosed in this document is a brushless DC motor including a housing having an end cap secured thereto. The housing encloses a rotor, a stator and a rotationally displaceable commutation board having 5 sensors secured thereon and spaced around the periphery of the rotor. An external rotational force is applied to the commutation board for displacement of the sensors to various positions whereby varying feedback signals are generated by the positioning of the sensors relative to the rotating rotor. The commutation board is secured in a fixed position in response to feedback signals indicative of optimum sensor position being determined. The rotation of the commutation board and the securing of the sensors in the desired fixed position is accomplished without requiring the removal of the 5 end cap and with the DC motor operating.

NASA

N95-26995* Syracuse Univ., NY. Dept. of Mechanical, Aerospace and Manufacturing Engineering.

THE NOISE REDUCTION POTENTIAL OF DUAL-STREAM COAXIAL RECTANGULAR IMPROPERLY EXPANDED JET FLOWS Final Report, Mar. 1991 - 1993

DARSHAN DOSANJH and ERIC F. SPINA Apr. 1995 10 p (Contract(s)/Grant(s): NAG1-1240) (NASA-CR-197820; NAS 1.26:197820) Avail: CASI HC A02/MF A01

The research performed began during Spring 1991 as a project to assess the noise reduction potential of rectangular coaxial nozzle configurations for improperly expanded jets. The research plan consisted of: (1) design of coaxial rectangular nozzle configuration by Syracuse graduate research assistant; (2) construction of nozzles by NASA Langley machinists; and (3) acquisition of preliminary acoustic and optical data for a variety of inner and outer jet pressure ratios.

Author

N95-26998 Houston Univ., TX. Dept. of Mechanical Engineering. **BASIC STUDIES IN TURBULENT SHEAR FLOWS Summary Report, Fiscal Year 1994**

FAZLE HUSSAIN 1994 33 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (Contract(s)/Grant(s): N00014-89-J-1361) (AD-A289145) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The goal of this research is to understand the underlying physics of turbulence phenomena through coherent structures (CS). The aim is not only to understand the flow physics but also to devise methods for turbulence prediction and control. Our approach utilizes experiment, numerics, and theory to understand both CS dynamics and structure. CS are studied in two ways: (1) long-time, global dynamics using experimental data and dynamical systems theory and (2) crucial, localized CS interactions understood via vorticity dynamics. Below, we have summarized results in several key areas: (1) global dynamics in a forced plane mixing layer (2) ODE models for spatially developing free shear flows, (3) core dynamics and transition in a plane mixing layer, (4) vorticity and helicity statistics in a circular jet, (5) new approaches to identifying sources of jet noise, and (6) the kinematic separation of homogeneous mixtures.

DTIC

12 ENGINEERING

N95-27179*# Institute for Computer Applications in Science and Engineering, Hampton, VA.

ACOUSTIC FIELD IN UNSTEADY MOVING MEDIA Final Report

F. BAUER (New York Univ., New York, NY.), L. MAESTRELLI, and L. TING (New York Univ., New York, NY.) May 1995 48 p (Contract(s)/Grant(s): NAS1-19480; RTOP 505-90-52-01) (NASA-CR-198162; NAS 1.26:198162; ICASE-95-39) Avail: CASI HC A03/MF A01

In the interaction of an acoustic field with a moving airframe the authors encounter a canonical initial value problem for an acoustic field induced by an unsteady source distribution, $q(t, x)$ with q equivalent to 0 for t less than or equal to 0, in a medium moving with a uniform unsteady velocity $U(t)$ in the coordinate system x fixed on the airframe. Signals issued from a source point S in the domain of dependence D of an observation point P at time t will arrive at point P more than once corresponding to different retarded times, τ in the interval $(0, t)$. The number of arrivals is called the multiplicity of the point S . The multiplicity equals 1 if the velocity U remains subsonic and can be greater when U becomes supersonic. For an unsteady uniform flow $U(t)$, rules are formulated for defining the smallest number of l subdomains $V(\text{sub } i)$ of D with the union of $V(\text{sub } i)$ equal to D . Each subdomain has multiplicity 1 and a formula for the corresponding retarded time. The number of subdomains $V(\text{sub } i)$ with nonempty intersection is the multiplicity m of the intersection. The multiplicity is at most l . Examples demonstrating these rules are presented for media at accelerating and/or decelerating supersonic speed. Author

N95-27240*# Nevada Univ., Reno, NV. Engineering Research and Development Center.

APPLICATION OF CFD TO THE ANALYSIS AND DESIGN OF HIGH-SPEED INLETS Final Report, 1 Jan. - 31 Dec. 1994

WILLIAM C. ROSE 25 May 1995 75 p Original contains color illustrations

(Contract(s)/Grant(s): NCC2-507)

(NASA-CR-198574; NAS 1.26:198574) Avail: CASI HC A04/MF A01; 15 functional color pages

Over the past seven years, efforts under the present Grant have been aimed at being able to apply modern Computational Fluid Dynamics to the design of high-speed engine inlets. In this report, a review of previous design capabilities (prior to the advent of functioning CFD) was presented and the example of the NASA 'Mach 5 inlet' design was given as the premier example of the historical approach to inlet design. The philosophy used in the Mach 5 inlet design was carried forward in the present study, in which CFD was used to design a new Mach 10 inlet. An example of an inlet redesign was also shown. These latter efforts were carried out using today's state-of-the-art, full computational fluid dynamics codes applied in an iterative man-in-the-loop technique. The potential usefulness of an automated machine design capability using an optimizer code was also discussed. Derived from text

N95-27354*# Dynamic Soft Analysis, Inc., Pittsburgh, PA.

CAE FOR THERMAL MANAGEMENT OF AEROSPACE ELECTRONIC BOARDS USING THE BETASOFT PROGRAM

KIMBERLY BOBISH In NASA. Lewis Research Center, The Sixth Annual Thermal and Fluids Analysis Workshop p 133-140 Jan. 1995 Avail: CASI HC A02/MF A03

Aerospace electronic boards require special attention to thermal management due to constraints such as their need to be light, small, and maintain high power densities. Also, cooling is mainly through conductive and radiative modes with minor or negligible convective cooling. Due to these particular requirements, thermal design has become an integrated part of the electronic design process in order to avoid expensive repeat prototyping and to ensure high reliability. To achieve high speed simulations, the BETASoft code uses semi-empirical formulations and an advanced finite difference scheme that incorporates local adaptive grids. Detailed

conduction, convection and radiation heat transfer is considered. Various benchmark verifications of the software simulation compared to infrared images typically prove to be within 10% of each other. The thermal analysis of a sample avionic card in a natural convection environment is shown. Then, the individual effects of attaching metal screws to the casing, increasing radiative emissivities of the casing, increasing the conductance of the wedge lock, adding an aluminum core to the board, adding metal strips in board layers, inserting conduction pads under components, and adding heat sinks to components are demonstrated. Author

N95-27699# Joint Publications Research Service, Arlington, VA. **JPRS REPORT: SCIENCE AND TECHNOLOGY. CENTRAL EURASIA**

17 May 1995 48 p Transl. into ENGLISH from various Russian articles

(JPRS-UST-94-022) Avail: CASI HC A03/MF A01

Some of the latest achievements in science & technology in Russia and Ukraine are compiled and reported. Brief summaries of publications relating to materials science, engineering and equipment, and life sciences are presented. Among the topics are those concerned with flight control of aerospace vehicles; the flow separation characteristics of turbomachinery; the hydrodynamics of bodies intersecting the free surface of liquids; and protective coatings for friction joints. CASI

N95-27854*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

TWO-PHASE FLOW RESEARCH USING THE LEARJET APPARATUS

JOHN B. MCQUILLEN and ERIC S. NEUMANN May 1995 16 p

(Contract(s)/Grant(s): RTOP 963-20-0C)

(NASA-TM-106814; E-9340; NAS 1.15:106814) Avail: CASI HC A03/MF A01

Low-gravity, gas-liquid flow research can be conducted aboard the NASA Lewis Learjet, the Lewis DC-9, or the Johnson Space Center KC-135. Air and water solutions serve as the test liquids in cylindrical test sections with an inner diameter of 1.27 cm and lengths up to 1.5 m. Superficial velocities range from 0.1 to 1.1 m/sec for liquids and from 0.1 to 25 m/sec for air. Flow rate, differential pressure, void fraction, film thickness, wall-shear stress, and acceleration data are measured and recorded throughout the 20 sec duration of the experiment. Flow is visualized by photographing at 400 frames with a high-speed, 16-mm camera. Author

N95-27855*# Army Research Lab., Cleveland, OH.

VIBRATION ANALYSIS OF A SPLIT PATH GEARBOX

TIMOTHY L. KRANTZ and MAJID RASHIDI (Cleveland State Univ., OH.) May 1995 15 p Presented at the 31st Joint Propulsion Conference, San Diego, CA, 10-12 Jul. 1995; cosponsored by AIAA, SAE, and ASME

(Contract(s)/Grant(s): RTOP 505-62-36; DA PROJ. 1L1-62211-A-47-A)

(NASA-TM-106875; E-9498; NAS 1.15:106875; ARL-TR-723; AIAA PAPER 95-3048) Avail: CASI HC A03/MF A01

Split path gearboxes can be attractive alternatives to the common planetary designs for rotorcraft, but because they have seen little use, they are relatively high risk designs. To help reduce the risk of fielding a rotorcraft with a split path gearbox, the vibration and dynamic characteristics of such a gearbox were studied. A mathematical model was developed by using the Lagrangian method, and it was applied to study the effect of three design variables on the natural frequencies and vibration energy of the gearbox. The first design variable, shaft angle, had little influence on the natural frequencies. The second variable, mesh phasing, had a strong effect on the levels of vibration energy, with phase angles of 0 deg and 180 deg producing low vibration levels. The third design variable, the stiffness of the shafts connecting the spur gears to the helical pinions, strongly influenced the natural frequencies of some of the vibration modes, including two of the dominant modes. We

found that, to achieve the lowest level of vibration energy, the natural frequencies of these two dominant modes should be less than those of the main excitation sources. Author

N95-27865* Virginia Polytechnic Inst. and State Univ., Blacksburg, VA. Center for Composite Materials and Structures
LOAD TRANSFER IN THE STIFFENER-TO-SKIN JOINTS OF A PRESSURIZED FUSELAGE Report, 1 Nov. 1991 - 30 Apr. 1995

ERIC R. JOHNSON and NAVEEN RASTOGI May 1995 222 p
(Contract(s)/Grant(s): NAG1-537)
(NASA-CR-198610; NAS 1.26:198610; CCMS-95-04; VPI-E-95-01)
Avail: CASI HC A10/MF A03

Structural analyses are developed to determine the linear elastic and the geometrically nonlinear elastic response of an internally pressurized, orthogonally stiffened, composite material cylindrical shell. The configuration is a long circular cylindrical shell stiffened on the inside by a regular arrangement of identical stringers and identical rings. Periodicity permits the analysis of a unit cell model consisting of a portion of the shell wall centered over one stringer-ring joint. The stringer-ring-shell joint is modeled in an idealized manner; the stiffeners are mathematically permitted to pass through one another without contact, but do interact indirectly through their mutual contact with the shell at the joint. Discrete beams models of the stiffeners include a stringer with a symmetrical cross section and a ring with either a symmetrical or an asymmetrical open section. Mathematical formulations presented for the linear response include the effect of transverse shear deformations and the effect of warping of the ring's cross section due to torsion. These effects are important when the ring has an asymmetrical cross section because the loss of symmetry in the problem results in torsion and out-of-plane bending of the ring, and a concomitant rotation of the joint at the stiffener intersection about the circumferential axis. Data from a composite material crown panel typical of a large transport fuselage structure are used for two numerical examples. Although the inclusion of geometric nonlinearity reduces the 'pillowing' of the shell, it is found that bending is localized to a narrow region near the stiffener. Including warping deformation of the ring into the analysis changes the sense of the joint rotation. Transverse shear deformation models result in increased joint flexibility. Author

N95-27882* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

INDUSTRY-WIDE WORKSHOP ON COMPUTATIONAL TURBULENCE MODELING

AAMIR SHABBIR, comp. Mar. 1995 271 p Workshop held in Cleveland, OH, 6-7 Oct. 1994; sponsored by Institute for Computational Mechanics in Propulsion; Center for Modeling of Turbulence and Transition; and Ohio Aerospace Inst.

(Contract(s)/Grant(s): NCC3-233; RTOP 505-90-5K)
(NASA-CP-10165; ICOMP-94-30; E-9295; NAS 1.55:10165; CMOTT-94-9) Avail: CASI HC A12/MF A03

This publication contains the presentations made at the Industry-Wide Workshop on Computational Turbulence Modeling which took place on October 6-7, 1994. The purpose of the workshop was to initiate the transfer of technology developed at Lewis Research Center to industry and to discuss the current status and the future needs of turbulence models in industrial CFD. For individual titles, see N95-27883 through N95-27902.

N95-27885* General Electric Co., Cincinnati, OH. Aircraft Engines.

A SUMMARY OF COMPUTATIONAL EXPERIENCE AT GE AIRCRAFT ENGINES FOR COMPLEX TURBULENT FLOWS IN GAS TURBINES

RONALD D. ZERKLE and CHANDER PRAKASH In NASA. Lewis Research Center, Industry-Wide Workshop on Computational Turbulence Modeling p 39-46 Mar. 1995

Avail: CASI HC A02/MF A03

This viewgraph presentation summarizes some CFD experience at GE Aircraft Engines for flows in the primary gaspath of a gas turbine engine and in turbine blade cooling passages. It is concluded

that application of the standard k-epsilon turbulence model with wall functions is not adequate for accurate CFD simulation of aerodynamic performance and heat transfer in the primary gas path of a gas turbine engine. New models are required in the near-wall region which include more physics than wall functions. The two-layer modeling approach appears attractive because of its computational complexity. In addition, improved CFD simulation of film cooling and turbine blade internal cooling passages will require anisotropic turbulence models. New turbulence models must be practical in order to have a significant impact on the engine design process. A coordinated turbulence modeling effort between NASA centers would be beneficial to the gas turbine industry. Derived from text

N95-27886* McDonnell-Douglas Aerospace, Saint Louis, MO.

THE APPLICABILITY OF TURBULENCE MODELS TO AERODYNAMIC AND PROPULSION FLOWFIELDS AT MCDONNELL-DOUGLAS AEROSPACE

LINDA D. KRAL, JOHN A. LADD, and MORI MANI In NASA. Lewis Research Center, Industry-Wide Workshop on Computational Turbulence Modeling p 47-63 Mar. 1995

Avail: CASI HC A03/MF A03

The objective of this viewgraph presentation is to evaluate turbulence models for integrated aircraft components such as the forebody, wing, inlet, diffuser, nozzle, and afterbody. The one-equation models have replaced the algebraic models as the baseline turbulence models. The Spalart-Allmaras one-equation model consistently performs better than the Baldwin-Barth model, particularly in the log-layer and free shear layers. Also, the Spalart-Allmaras model is not grid dependent like the Baldwin-Barth model. No general turbulence model exists for all engineering applications. The Spalart-Allmaras one-equation model and the Chien k-epsilon models are the preferred turbulence models. Although the two-equation models often better predict the flow field, they may take from two to five times the CPU time. Future directions are in further benchmarking the Menter blended k-w/k-epsilon and algorithmic improvements to reduce CPU time of the two-equation model. Derived from text

N95-27889* General Electric Co., Cincinnati, OH. Aircraft Engines.

COMBUSTION SYSTEM CFD MODELING AT GE AIRCRAFT ENGINES

D. BURRUS, H. MONGIA, ANIL K. TOLPADI (General Electric Co., Schenectady, NY.), S. CORREA (General Electric Co., Schenectady, NY.), and M. BRAATEN (General Electric Co., Schenectady, NY.) In NASA. Lewis Research Center, Industry-Wide Workshop on Computational Turbulence Modeling p 87-97 Mar. 1995

Avail: CASI HC A03/MF A03

This viewgraph presentation discusses key features of current combustion system CFD modeling capabilities at GE Aircraft Engines provided by the CONCERT code; CONCERT development history; modeling applied for designing engine combustion systems; modeling applied to improve fundamental understanding; CONCERT3D results for current production combustors; CONCERT3D model of NASA/GE E3 combustor; HYBRID CONCERT CFD/Monte-Carlo modeling approach; and future modeling directions. CASI

N95-27980* Sandia National Labs., Albuquerque, NM.

A NASTRAN-BASED COMPUTER PROGRAM FOR STRUCTURAL DYNAMIC ANALYSIS OF HORIZONTAL AXIS WIND TURBINES

DON W. LOBITZ In DASCON Engineering, Collected Papers on Wind Turbine Technology p 89-97 May 1995 Sponsored by DOE (Contract(s)/Grant(s): DE-AC04-76DP-00789)

Avail: CASI HC A02/MF A03

This paper describes a computer program developed for structural dynamic analysis of horizontal axis wind turbines (HAWT's). It is based on the finite element method through its reliance on NASTRAN for the development of mass, stiffness, and damping matrices of the tower end rotor, which are treated in NASTRAN as separate structures. The tower is modeled in a stationary frame and

the rotor in one rotating at a constant angular velocity. The two structures are subsequently joined together (external to NASTRAN) using a time-dependent transformation consistent with the hub configuration. Aerodynamic loads are computed with an established flow model based on strip theory. Aeroelastic effects are included by incorporating the local velocity and twisting deformation of the blade in the load computation. The turbulent nature of the wind, both in space and time, is modeled by adding in stochastic wind increments. The resulting equations of motion are solved in the time domain using the implicit Newmark-Beta integrator. Preliminary comparisons with data from the Boeing/NASA MOD2 HAWT indicate that the code is capable of accurately and efficiently predicting the response of HAWT's driven by turbulent winds. Author

**N95-27982*# General Electric Co., Schenectady, NY.
CALCULATION OF DESIGN LOAD FOR THE MOD-5A 7.3
MW WIND TURBINE SYSTEM**

L. MIRANDY and J. C. STRAIN *In* DASCON Engineering, Collected Papers on Wind Turbine Technology p 115-138a May 1995
(Contract(s)/Grant(s): DEN3-153)
Avail: CASI HC A03/MF A03

Design loads are presented for the General Electric MOD-SA wind turbine. The MOD-SA system consists of a 400 ft. diameter, upwind, two-bladed, teetered rotor connected to a 7.3 mW variable-speed generator. Fatigue loads are specified in the form of histograms for the 30 year life of the machine, while limit (or maximum) loads have been derived from transient dynamic analysis at critical operating conditions. Loads prediction was accomplished using state of the art aeroelastic analyses developed at General Electric. Features of the primary predictive tool - the Transient Rotor Analysis Code (TRAC) are described in the paper. Key to the load predictions are the following wind models: (1) yearly mean wind distribution; (2) mean wind variations during operation; (3) number of start/shutdown cycles; (4) spatially large gusts; and (5) spatially small gusts (local turbulence). The methods used to develop statistical distributions from load calculations represent an extension of procedures used in past wind programs and are believed to be a significant contribution to Wind Turbine Generator analysis. Test/theory correlations are presented to demonstrate code load predictive capability and to support the wind models used in the analysis. In addition MOD-5A loads are compared with those of existing machines. The MOD-5A design was performed by the General Electric Company, Advanced Energy Program Department, under Contract DEN3-153 with NASA Lewis Research Center and sponsored by the Department of Energy. Author

**N95-27983*# Boeing Aerospace Co., Seattle, WA.
COMPARISON OF MEASURED AND CALCULATED
DYNAMIC LOADS FOR THE MOD-2 2.5 MW WIND TURBINE
SYSTEM**

D. K. ZIMMERMAN, S. A. SHIPLEY, and R. D. MILLER *In* DASCON Engineering, Collected Papers on Wind Turbine Technology p 139-152 May 1995
Avail: CASI HC A03/MF A03

The Boeing Company, under contract to the Electric Power Research Institute (EPRI), has completed a test program on the Mod-2 wind turbines at Goodnoe Hills, Washington. The objectives were to update fatigue load spectra, discern site and machine differences, measure vortex generator effects, and to evaluate rotational sampling techniques. This paper shows the test setup and loads instrumentation, loads data comparisons and test/analysis correlations. Test data are correlated with DYLOSAT predictions using both the NASA interim turbulence model and rotationally sampled winds as inputs. The latter is demonstrated to have the potential to improve the test/analysis correlations. The paper concludes with an assessment of the importance of vortex generators, site dependence, and machine differences on fatigue loads. The adequacy of prediction techniques used are evaluated and recommendations are made for improvements to the methodology. Author

**N95-27985*# General Electric Co., Philadelphia, PA.
CONTROL SYSTEM DESIGN FOR THE MOD-5A 7.3 MW
WIND TURBINE GENERATOR**

ROBERT S. BARTON, THEODORE J. HOSP, and GEORGE P. SCHANZENBACH *In* DASCON Engineering, Collected Papers on Wind Turbine Technology p 157-174 May 1995 Presented at the DOE/NASA Workshop on Horizontal Axis Wind Turbine Technology, Cleveland, OH, 8-10 May 1984
(Contract(s)/Grant(s): DEN3-153)
Avail: CASI HC A03/MF A03

This paper provides descriptions of the requirements analysis, hardware development and software development phases of the Control System design for the MOD-5A 7.3 mW Wind Turbine Generator. The system, designed by General Electric Company, Advanced Energy Programs Department, under contract DEN 3-153 with NASA Lewis Research Center and DOE, provides real time regulation of rotor speed by control of both generator torque and rotor torque. A variable speed generator system is used to provide both airgap torque control and reactive power control. The wind rotor is designed with segmented ailerons which are positioned to control blade torque. The central component of the control system, selected early in the design process, is a programmable controller used for sequencing, alarm monitoring, communication, and real time control. Development of requirements for use of aileron controlled blades and a variable speed generator required an analytical simulation that combined drivetrain, tower and blade elastic modes with wind disturbances and control behavior. An orderly two phase plan was used for controller software development. A microcomputer based turbine simulator was used to facilitate hardware and software integration and test. Author

**N95-27986*# Boeing Aerospace Co., Seattle, WA.
USE OF BLADE PITCH CONTROL TO PROVIDE POWER
TRAIN DAMPING FOR THE MOD-2, 2.5-MW WIND TURBINE**

W. A. BLISSELL, JR. *In* DASCON Engineering, Collected Papers on Wind Turbine Technology p 175-1190 May 1995 Presented at the DOE/NASA Workshop on Horizontal Axis Wind Turbine Technology, Cleveland, OH, 8-10 May 1984 Sponsored by DOE
(Contract(s)/Grant(s): DEN3-153)
Avail: CASI HC A02/MF A03

The Control System for the Mod-2 wind turbine system is required to provide not only for startup, RPM regulation, maximizing or regulating power, and stopping the rotor, but also for load limiting, especially in the power train. Early operations with above-rated winds revealed an instability which was caused primarily by coupling between the quill shaft and the rotor air loads. This instability caused the first of several major Mod-2 Control System changes which are reviewed in the paper. Author

**N95-27989*# General Electric Co., Philadelphia, PA.
VARIABLE SPEED GENERATOR APPLICATION ON THE
MOD-5A 7.3 MW WIND TURBINE GENERATOR**

ROBERT S. BARTON *In* DASCON Engineering, Collected Papers on Wind Turbine Technology p 199-210 May 1995 Presented at the DOE/NASA Workshop on Horizontal Axis Wind Turbine Technology, Cleveland, OH, 8-10 May 1984
Avail: CASI HC A03/MF A03

This paper describes the application of a Scherbiustat type variable speed subsystem in the MOD-5A Wind Turbine Generator. As designed by General Electric Company, Advanced Energy Programs Department, under contract DEN3-153 with NASA Lewis Research Center and DOE, the MOD-5A utilizes the subsystem for both starting assistance in a motoring mode and generation in a controlled airgap torque mode. Reactive power control is also provided. The Scherbiustat type arrangement of a wound rotor machine with a cycloconverter in the rotor circuit was selected after an evaluation of variable speed technologies that followed a system evaluation of drivetrain cost and risk. The paper describes the evaluation factors considered, the results of the evaluations and summarizes operating strategy and performance simulations. Author

N95-27999* Douglas Aircraft Co., Inc., Long Beach, CA. Advanced Aircraft Systems Dept.

EVALUATION OF ALL-ELECTRIC SECONDARY POWER FOR TRANSPORT AIRCRAFT Final Report

W. E. MURRAY, L. J. FEINER, and R. R. FLORES 24 Jan. 1992 311 p

(Contract(s)/Grant(s): NAS3-25965)

(NASA-CR-189077; NAS 1.26:189077; MDC-91K0418) Avail: CASI HC A14/MF A03

This report covers a study by Douglas Aircraft Company (DAC) of electrical power systems for advanced transport aircraft based upon an all-electric design concept. The concept would eliminate distributed hydraulic and pneumatic secondary power systems, and feature an expanded secondary electrical power system redesigned to supply power to the loads customarily supplied by hydraulic or pneumatic power. The initial study was based on an advanced 20-kHz electrical power transmission and distribution system, using a system architecture supplied by NASA-Lewis Research Center for twin-engine aircraft with many advanced power conversion concepts. NASA-LeRC later requested DAC to refocus the study on 400-Hz secondary power distribution. Subsequent work was based on a three-engine MD-11 aircraft, selected by DAC as a baseline system design that would provide data for the comparative cost/benefit analysis. The study concluded that the 20-kHz concept produced many expected benefits, and that the all-electric trijet weight savings on hardware redesign would be 2,304 pounds plus a 2.1-percent fuel reduction and resized for a total weight reduction of 11,000 pounds. Cost reductions for a fleet of 800 aircraft in a 15-year production program were estimated at \$76.71 million for RDT&E; \$2.74 million per aircraft for production; \$9.84 million for nonrecurring expenses; \$120,000 per aircraft for product support; and \$300,000 per aircraft per year for operating and maintenance costs, giving a present value of \$1.914 billion saved or a future value of \$10.496 billion saved. Author

N95-28029# Lawrence Livermore National Lab., Livermore, CA. **A HYBRID VEHICLE EVALUATION CODE AND ITS APPLICATION TO VEHICLE DESIGN. REVISION 1**

S. M. ACEVES and J. R. SMITH 15 Sep. 1994 26 p Presented at the Society of Automotive Engineers International Congress and Exposition, Detroit, MI, 27 Feb. - 2 Mar. 1995

(Contract(s)/Grant(s): W-7405-ENG-48)

(DE95-008053; UCRL-JC-117918-REV-1; CONF-950256-1) Avail: CASI HC A03/MF A01

This paper describes a hybrid vehicle simulation model which can be applied to many of the vehicles currently being considered for low pollution and high fuel economy. The code operates in batch mode with all the vehicle information stored in data files. The code calculates fuel economy for three driving schedules, time for 0-96 km/h at maximum acceleration, hill climbing performance, power train dimensions, and pollution generation rates. This paper also documents the application of the code to a hybrid vehicle that utilizes a hydrogen internal combustion engine. The simulation model is used for parametric studies of the vehicle. The results show the fuel economy of the vehicle as a function of vehicle mass, aerodynamic drag, engine efficiency, accessory load, and flywheel efficiency. The code also calculates the minimum flywheel energy and power to obtain a desired performance. The hydrogen hybrid vehicle analyzed in the paper has a predicted range of 480 km (300 miles), with a gasoline equivalent fuel efficiency of 34.2 km/liter (80.9 mpg). DOE

N95-28139# Lawrence Livermore National Lab., Livermore, CA. **A HYBRID VEHICLE EVALUATION CODE AND ITS APPLICATION TO VEHICLE DESIGN. REVISION 2**

S. M. ACEVES and J. R. SMITH 13 Dec. 1994 26 p Presented at the Society of Automotive Engineers International Congress and Exposition, Detroit, MI, 27 Feb. - 2 Mar. 1995

(Contract(s)/Grant(s): W-7405-ENG-48)

(DE95-008060; UCRL-JC-117918-REV-2; CONF-950256-1-REV-2) Avail: CASI HC A03/MF A01

This paper describes a hybrid vehicle simulation model which

can be applied to many of the vehicles currently being considered for low pollution and high fuel economy. The code operates in batch mode with all the vehicle information stored in data files. The code calculates power train dimensions, fuel economy for three driving schedules, time for 0-96 km/h at maximum acceleration, hill climbing performance, and pollution generation rates. This paper also documents the application of the code to a hybrid vehicle that utilizes a hydrogen internal combustion engine. The simulation model is used for parametric studies of the vehicle. The results show the fuel economy of the vehicle as a function of vehicle mass, aerodynamic drag, engine efficiency, accessory load, and flywheel efficiency. The code also calculates the minimum flywheel energy and power to obtain a desired performance. The hydrogen hybrid vehicle analyzed in the paper has a range of 480 km (300 miles), with a predicted gasoline equivalent fuel efficiency of 33.7 km/liter (79.3 mpg). DOE

N95-28364* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

BEARING DEFECT SIGNATURE ANALYSIS USING ADVANCED NONLINEAR SIGNAL ANALYSIS IN A CONTROLLED ENVIRONMENT Final Report

T. ZOLADZ, E. EARTHART, and T. FIORUCCI Washington May 1995 48 p

(Contract(s)/Grant(s): CDDF PROJ. 93-10)

(NASA-TM-108491; NAS 1.15:108491) Avail: CASI HC A03/MF A01

Utilizing high-frequency data from a highly instrumented rotor assembly, seeded bearing defect signatures are characterized using both conventional linear approaches, such as power spectral density analysis, and recently developed nonlinear techniques such as bicoherence analysis. Traditional low-frequency (less than 20 kHz) analysis and high-frequency envelope analysis of both accelerometer and acoustic emission data are used to recover characteristic bearing distress information buried deeply in acquired data. The successful coupling of newly developed nonlinear signal analysis with recovered wideband envelope data from accelerometers and acoustic emission sensors is the innovative focus of this research. Author

N95-28467* Lockheed Aeronautical Systems Co., Marietta, GA. **STRUCTURAL TESTING OF THE TECHNOLOGY INTEGRATION BOX BEAM**

C. F. GRIFFIN In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 659-671 Sep. 1992 Previously announced as X92-10409

Avail: CASI HC A03/MF A04

A full-scale section of a transport aircraft wing box was designed, analyzed, fabricated, and tested. The wing box section, which was called the technology integration box beam, contained blade stiffened covers and T-stiffened channel spars constructed using graphite/epoxy materials. Covers, spars, and the aluminum ribs were assembled using mechanical fasteners. The box beam was statically tested for several loading conditions to verify the stiffness and strength characteristics of the composite wing design. Failure of the box beam occurred at 125 percent of design limit load during the combined upbending and torsion ultimate design load test. It appears that the failure initiated at a stiffener runout location in the upper cover which resulted in rupture of the upper cover and portions of both spars. Author

N95-28468* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

TECHNOLOGY INTEGRATION BOX BEAM FAILURE STUDY Status Report

MARK J. SHUART, DAMODAR R. AMBUR (Lockheed Aeronautical Systems Co., Marietta, GA.), D. D. DAVIS, JR. (Lockheed Aeronautical Systems Co., Marietta, GA.), R. C. DAVIS (Lockheed Aeronautical Systems Co., Marietta, GA.), G. L. FARLEY (Lockheed Aeronautical Systems Co., Marietta, GA.), C. G. LOTTS (Lockheed Aeronautical Systems Co., Marietta, GA.), and J. T. WANG (Lockheed Aeronautical Systems Co., Marietta, GA.) In FAA, Ninth DOD/

12 ENGINEERING

NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 673-685 Sep. 1992 Previously announced as X92-10410

Avail: CASI HC A03/MF A04

The objective of this paper is to describe current results from an on-going study of the mechanisms that led to the failure of the TIBB. Experimental and analytical results are presented. Experimental results include load, strain, and deflection data for the TIBB (Technology Integration Box Beam). An analytical investigation was conducted to compliment the experimental investigation and to gain additional insight into the TIBB structural response. Analytical results include strain and deflection results from a global analysis of the TIBB. A local analysis of the failure region is being completed. These analytical results are validated through comparisons with the experimental results from the TIBB tests. The experimental and analytical results from the TIBB tests are used to determine a sequence of events that may have resulted in failure of the TIBB. A potential cause of failure is high stresses in a stiffener runout region. Typical analytical results are presented for a stiffener runout specimen that is being defined to simulate the TIBB failure mechanisms. The results of this study are anticipated to provide better understanding of potential failure mechanisms in composite aircraft structures, to lead to future design improvements, and to identify needed analytical tools for design and analysis. Derived from text

N95-28484*# Stanford Univ., CA. Dept. of Aeronautics and Astronautics.

COMPRESSIVE STRENGTH OF DAMAGED AND REPAIRED COMPOSITE PLATES

SCOTT R. FINN and GEORGE S. SPRINGER In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 1083-1095 Sep. 1992

(Contract(s)/Grant(s): NAS1-18778)

Avail: CASI HC A03/MF A04

Tests were performed assessing the effectiveness of repair in restoring the mechanical properties of damaged, solid composite plates made of Fiberite T300/976 graphite-epoxy. Some (75%) or all (100%) of the damaged zone was cut out, and the plate was repaired by plugging and patching the hole. The effectiveness of the repair was evaluated by measuring the compressive strengths of undamaged plates, damaged plates with no cutout, damaged plates with a cutout, and plates that had been repaired. Author

N95-28649 Strathclyde Univ., Glasgow (Scotland).

SMART MATERIALS: SURFACES, TRANSFORMS AND INTERFACES. THE COMMENSURATE ENGINEERING DIMENSION

ALASTER MCDONACH, PETER T. GARDINER, RON S. MCEWEN, and BRIAN CULSHAW 18 Nov. 1994 391 p Presented at the Second European Conference on Smart Structures and Materials, Glasgow, England, 1994 Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): N0014-94-J-9030)

(AD-A289598) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The future of molecularly based smart materials hinges on the development of integrated technologies addressing synthesis, assembly, shaping, etc. and some of these are now becoming clear. Even in the bolt on era new technologies will allow issues of commensurate engineering to be addressed. DTIC

N95-28673*# Institute for Computer Applications in Science and Engineering, Hampton, VA.

RESPONSE OF MULTI-PANEL ASSEMBLY TO NOISE FROM A JET IN FORWARD MOTION Final Report

A. BAYLISS (Northwestern Univ., Evanston, IL.), L. MAESTRELLO (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.), J. L. MCGREEVY (Philadelphia Coll. of Pharmacy and Science, PA.), and C. C. FENNO, JR. (National Academy of Sciences - National Research Council, Hampton, VA.) May 1995 30 p Submitted for publication

(Contract(s)/Grant(s): NAS1-19480; RTOP 505-90-52-01) (NASA-CR-198164; NAS 1.26:198164; ICASE-95-41) Avail: CASI HC A03/MF A01

A model of the interaction of the noise from a spreading subsonic jet with a 4 panel assembly is studied numerically in two dimensions. The effect of forward motion of the jet is accounted for by considering a uniform flow field superimposed on a mean jet exit profile. The jet is initially excited by a pulse-like source inserted into the flow field. The pulse triggers instabilities associated with the inviscid instability of the jet shear layer. These instabilities generate sound which in turn serves to excite the panels. We compare the sound from the jet, the responses of the panels and the resulting acoustic radiation for the static jet and the jet in forward motion. The far field acoustic radiation, the panel response and sound radiated from the panels are all computed and compared to computations of a static jet. The results demonstrate that for a jet in forward motion there is a reduction in sound in downstream directions and an increase in sound in upstream directions in agreement with experiments. Furthermore, the panel response and radiation for a jet in forward motion exhibits a downstream attenuation as compared with the static case. Author

13

GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A95-83591

DATA PROCESSING AND MAPPING IN AIRBORNE RADIOMETRIC SURVEYS

GEORG F. SCHWARZ Inst. fuer Geophysik, Switzerland, LADISLAUS RYBACH Inst. fuer Geophysik, Switzerland, and EMILE E. KLINGELE Inst. fuer Geophysik, Switzerland ITC Journal (ISSN 0303-2434) no. 1 1994 p. 34-39 (HTN-95-51587) Copyright

Helicopter surveys permit rapid evaluation with complete areal coverage of the terrestrial gamma radiation from natural artificial radio isotopes in the topmost layer of the ground. The gamma spectrometric measurements (256 channels) are performed by a 16.8 liter NaI detector. In order to identify possible radiation level changes around the five Swiss nuclear installations (four power plants and one research facility), the surrounding regions of each site and surveyed annually. In addition, regions with elevated natural radioactivity are mapped within the context of the Swiss national geophysical survey. In case of accidents with radioactive material or debris of nuclear-powered satellites, the system would be used to locate the radioactive sources. Author (Hemer)

A95-83627

MAPPING OF FOREST FIRE DAMAGES USING IMAGING SPECTROSCOPY

C. OLBERT Free Univ. of Berlin, Berlin, Germany, M. SCHAALE Free Univ. of Berlin, Berlin, Germany, and R. FURRER Free Univ. of Berlin, Berlin, Germany Natural hazards: Monitoring and assessment using remote sensing technique; Meeting A3.2 of the COSPAR Scientific Assembly, 30th, Hamburg, Germany, July 11-21, 1994. A95-83614 Advances in Space Research (ISSN 0273-1177) vol. 15, no. 11 1995 p. 115-122

Copyright

An airborne spectroscopic imager (casi) was flown over a region which was damaged by a forest fire while the radiance from the ground was measured from the blue to the near-IR spectral region. A correlation matrix analysis and the normalized difference vegetation index reveals different degrees (classes) of destruction. More details however can be extracted from a neural analysis in course of auto-associative recalls in a space of reference vectors based on a self-organizing feature map. Author (Hemer)

A95-83827

FRACTAL PROPERTIES OF WHITECAPS

B. R. KERMAN Atmospheric Environment Service, Burlington, Ontario, Canada and K. SZETO University of Toronto, Toronto, Ontario, Canada Atmosphere-Ocean (ISSN 0705-5900) vol. 32, no. 3 September 1994 p. 531-551
(HTN-95-92121) Copyright

Images of a field of breaking waves over the ocean obtained using a line-scanner on an aircraft are analyzed for a possible fractal geometry. The cumulative probability function of the intensity is shown to be self-similar for sufficiently large intensities occupying about 10% of an imaged area. This structure is invariant to successive averaging over successively larger boxes. A box-counting technique was applied to images of one representative flight. The estimated fractal dimension decreases from about 2.25 for a 10% areal coverage to about 1.7 for 0.1% coverage. It is concluded that the spatial distribution of the scattered light from foam and whitecaps is not monofractal, but is instead multifractal. Author (Hemer)

A95-84526

AIR TRUTH VALIDATION OF CLOUD ALBEDO ESTIMATED FROM NOAA ADVANCED VERY HIGH RESOLUTION RADIOMETER DATA

TADAHIRO HAYASAKA Tohoku Univ., Sendai, Japan, MAKOTO KUJI Tohoku Univ., Sendai, Japan, and MASAYUKI TANAKA Tohoku Univ., Sendai, Japan Journal of Geophysical Research (ISSN 0148-0227) vol. 99, no. D9 September 20, 1994 p. 18,685-18,693

(HTN-95-A1021) Copyright

A comparison was carried out between cloud albedos observed in situ by aircraft and cloud albedos calculated with visible optical thickness retrieved from the NOAA advanced very high resolution radiometer channel 1 radiance data. The results show that the observed and calculated cloud albedos in the visible region are coincident with each other in a few percent for both homogeneous stratus and rather inhomogeneous stratocumulus clouds as long as the cloud amount is large. In the near-infrared region, on the other hand, the observed albedo is lower than that evaluated from the satellite data for stratocumulus clouds, while the observed and calculated albedos are consistent for stratus clouds. From the aircraft observation of solar radiative flux this discrepancy is not ascribed to the uncertainty in the near-infrared absorption processes as discussed in previous studies. Author (Hemer)

A95-84543* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

EFFECTS OF A POLAR STRATOSPHERE CLOUD PARAMETERIZATION ON OZONE DEPLETION DUE TO STRATOSPHERIC AIRCRAFT IN A TWO-DIMENSIONAL MODEL

DAVID B. CONSIDINE Applied Research Corp., Landover, MD, US, ANNE R. DOUGLASS NASA. Goddard Space Flight Center, Greenbelt, MD, US, and CHARLES H. JACKMAN NASA. Goddard Space Flight Center, Greenbelt, MD, US Journal of Geophysical Research (ISSN 0148-0227) vol. 99, no. D9 September 20, 1994 p. 18,879-18,894

(HTN-95-A1038) Copyright

A parameterization of Type 1 and 2 polar stratospheric cloud (PSC) formation is presented which is appropriate for use in two-dimensional (2-D) photochemical models of the stratosphere. The calculations of PSC frequency of occurrence and surface area density uses climatological temperature probability distributions obtained from National Meteorological Center data to avoid using zonal mean temperatures, which are not good predictors of PSC behavior. The parameterization does not attempt to model the microphysics of PSCs. The parameterization predicts changes in PSC formation and heterogeneous processing due to perturbations of stratospheric trace constituents. It is therefore useful in assessing the potential effects of a fleet of stratospheric aircraft (high speed civil transports, or HSCTs) on stratospheric composition. The model calculated frequency of PSC occurrence agrees well with a climatology based on stratospheric

aerosol measurement (SAM) 2 observations. PSCs are predicted to occur in the tropics. Their vertical range is narrow, however, and their impact on model O₃ fields is small. When PSC and sulfate aerosol heterogeneous processes are included in the model calculations, the O₃ change for 1980 - 1990 is in substantially better agreement with the total ozone mapping spectrometer (TOMS)-derived O₃ trend than otherwise. The overall changes in model O₃ response to standard HSCT perturbation scenarios produced by the parameterization are small and tend to decrease the model sensitivity to the HSCT perturbation. However, in the southern hemisphere spring a significant increase in O₃ sensitivity to HSCT perturbations is found. At this location and time, increased PSC formation leads to increased levels of active chlorine, which produce the O₃ decreases. Author (Hemer)

A95-84549

EVOLUTION OF THE CONCENTRATIONS OF TRACE SPECIES IN AN AIRCRAFT PLUME: TRAJECTORY STUDY

MICHAEL Y. DANILIN York Univ., North York, Canada, ADOLF EBEL Cologne Univ., Cologne, Germany, HENDRIK ELBERN Cologne Univ., Cologne, Germany, and HERIBERT PETRY Cologne Univ., Cologne, Germany Journal of Geophysical Research (ISSN 0148-0227) vol. 99, no. D9 September 20, 1994 p. 18,951-18,972 Research sponsored by Deutscher Akademischer Austauschdienst and NSERC

(HTN-95-A1044) Copyright

Permanent increase of the subsonic aviation flights and attempts to develop high-speed civil transport (HSCT) necessitate an assessment of their possible environment impacts. To evaluate global aviation effects, it is important to know the role of the chemical transformations inside an aircraft plume taking into account heterogeneous reactions. The goal of this work is to model the principal physical and chemical processes occurring inside an aircraft exhaust plume. A new box model which calculates 41 relevant O(x), HO(x), NO(x), ClO(x), BrO(x), SO(x), and hydrocarbon species and includes the possible heterogeneous reactions on the combustion aerosol and ice contrail particles is proposed. The simplified descriptions of the aircraft plume dilution and ice contrail formation are described. The transformation inside the aircraft wake are presented for the trajectories of the exhaust product motions at the levels of 200 and 100 mbar calculated for the particular atmospheric conditions on April 25, 1986. The following problems are discussed: the ozone response at these altitudes, the oxidation rate of NO(x) and SO₂, the role of the heterogeneous reactions on the combustion aerosol and contrail particles, and the possibility of ice and nitric acid trihydrate particle formation inside the wake. The model results are in agreement with available experimental data for NO, NO₂, HNO₃, HNO₂, and SO₂. Analytical expressions are proposed to evaluate the oxidation rates of NO(x) and SO₂ in the aircraft wake. The local ozone response is small (between 0.6% at 200 mb and -0.1% at 100 mb). Possible future investigations are proposed. Author (Hemer)

A95-84783

CUTS ENDANGER AIRBORNE RESEARCH

WILLIAM B. SCOTT Aviation Week & Space Technology (ISSN 0005-2175) vol. 140, no. 19 May 9, 1994 p. 28

(HTN-95-20602) Copyright

A planned reorganization at NASA Ames Research Center, with attendant program reductions, threaten to reduce airborne science support by 50%. Currently funded NASA airborne science programs are described, and the effects of the reorganization cuts are discussed. Hemer

A95-86272

AN OVERVIEW OF THE EASOE CAMPAIGN

J. A. PYLE University of Cambridge, Cambridge, UK, N. R. P. HARRIS University of Cambridge, Cambridge, UK, J. C. FARMAN European Ozone Research Coordinating Unit, UK, F. ARNOLD Max-Planck-Institut fuer Kernphysik, Heidelberg, Germany, G. BRAATHEN NILU, Lillestrom, Norway, R. A. COX MASD NERC HQ, Swindon, UK, P. FAUCON CNES, Aire sur l'Adour, France, R. L. JONES University of Cambridge, Cambridge, UK, G. MEGIE

Universite P. et M. Curie, Paris, France, A. O'NEILL University of Reading, Reading, UK et al. Geophysical Research Letters (ISSN 0094-8276) vol. 21, no. 13 June 22, 1994 p. 1191-1194 Research supported by the DGXII of the CEC and the UK Department of the Environment (HTN-95-00702) Copyright

An overview of the planning of the European Arctic Ozone Experiment (EASOE) was presented. The purpose of the project was to study processes in the Arctic leading to ozone destruction and their link with processes occurring in northern middle latitudes. Data were collected from November 1991 to March 1992 with ozonesonde measurements to define a chemistry of ozone, performing case studies of fast chemical processes occurring in the troposphere and stratosphere and tropospheric synoptically and orographically forced ozone miniholes and polar stratospheric clouds, obtaining complementary observations from aircraft, ground based stations, and balloons for operational forecasting and post project data interpretation, and defining the requirements for a European Stratospheric Monitoring Network. Measurements for EASOE were made from 16 ground-based sites, three research aircraft, 43 stratospheric balloons launched in northern Sweden, and from ozonesondes at 22 European sites. Ground based data from the total ozone monitoring network and from satellites (TOMS, TOVS) were available in real time. These data were complemented by meteorological data from the European Center for Medium Range Weather Forecasts and the United Kingdom Meteorological Office. Hemer

A95-86291

AIRCRAFT MEASUREMENTS OF ClO AND HCl DURING EASOE 1991/92

S. CREWELL University of Bremen, Germany, K. KUNZI University of Bremen, Germany, H. NETT University of Bremen, Germany, T. WEHR University of Bremen, Germany, and P. HARTOGH Max-Planck-Institut für Aeronomie, Katlenburg-Lindau, Germany Geophysical Research Letters (ISSN 0094-8276) vol. 21, no. 13 June 22, 1994 p. 1267-1270 Research supported by the ESA, the State of Bremen and the Bundesministerium für Forschung und Technologie (HTN-95-00721) Copyright

As part of the European Arctic Stratospheric Ozone Experiment (EASOE), performed in the winter period 1991/92, stratospheric chlorine monoxide (ClO) and hydrochloric acid (HCl) have been observed using the Submillimeter Atmospheric Sounder (SUMAS). The instrument measures the thermal emission of the atmosphere in the frequency range 620-650 GHz. Due to strong tropospheric water vapor absorption in this frequency range the radiometer has to be operated on-board a high-flying aircraft. During EASOE several flight missions were performed over northern Europe in the periods 10-13 December 1991, 5-14 February 1992 and 7-13 March 1992 using the research aircraft FALCON operated by the German Air and Space Organization (DLR). We report on two flights in February and two in March. From a first analysis it is found that the HCl column content as observed during the March flight, increased by about 20-30% compared to the results for the mid-February flight. On the other hand, high ClO amounts, particularly at lower altitudes, were observed in February. From the observed trends for the ClO and HCl abundances we assume that some HCl had been converted to reactive chlorine indicating a chemically disturbed Arctic vortex in February. Author (Hemer)

A95-86292* National Aeronautics and Space Administration, Washington, DC.

AN OVERVIEW OF MILLIMETER-WAVE SPECTROSCOPIC MEASUREMENTS OF CHLORINE MONOXIDE AT THULE, GREENLAND, FEBRUARY-MARCH, 1992: VERTICAL PROFILES, DIURNAL VARIATION, AND LONGER-TERM TRENDS

R. L. DE ZAFRA State University of New York, Stony Brook, NY, US, L. K. EMMONS State University of New York, Stony Brook, NY, US, J. M. REEVES State University of New York, Stony Brook, NY, US, and D. T. SHINDELL State University of New York, Stony Brook, NY,

US Geophysical Research Letters (ISSN 0094-8276) vol. 21, no. 13 June 22, 1994 p. 1271-1274 (Contract(s)/Grant(s): NAGW-2182; NAG1-1254; NSF ATM-84-19733) (HTN-95-00722) Copyright

Measurements of chlorine monoxide in the stratosphere over Thule, Greenland (73.6 N, 68.4 W) were made quasi-continuously during the period February 8 to March 24, 1992, using a high-sensitivity ground based mm-wave spectrometer. These observations give diurnal, short term, and long term changes in the mixing ratio and vertical distribution of ClO. At an equivalent time after the Antarctic winter solstice, very large concentrations (up to approximately 1.5 ppbv) occur in lower stratospheric ClO, resulting in massive ozone destruction. We saw no evidence for large (approximately 1 to 1.5 ppbv) amounts of ClO in the 16-25 km range over Thule in February or March, in agreement with UARS (satellite) observations by the MLS mm-wave spectrometer for this period, and in marked contrast to UARS/MLS and ER-2 aircraft measurements over northern Europe and eastern Canada, respectively, during January, 1992. We have evidence for smaller enhancements (approximately 0.2 to 0.5 ppbv) in the 18-30 km range during late February-early March, which could result from transport of residual low NO₂ air following earlier polar stratospheric cloud (PSC) processing (the last of which occurred at least one month earlier, however) or the result of chemical processing by Pinatubo aerosols. Direct influence of Pinatubo aerosols on Arctic ozone during the spring of 1992 has been difficult to assess, and this enhancement of low-altitude ClO might be a significant indicator of aerosol effects. Author (Hemer)

A95-86296

TWO DIMENSIONAL STRATOSPHERIC AEROSOL DISTRIBUTIONS DURING EASOE

M. WIRTH Institute of Atmospheric Physics, Germany, G. EHRET Institute of Atmospheric Physics, Germany, P. MORL Institute of Atmospheric Physics, Germany, and W. RENGIER Institute of Atmospheric Physics, Germany Geophysical Research Letters (ISSN 0094-8276) vol. 21, no. 13 June 22, 1994 p. 1287-1290 Research supported by the CEC and the German Ministry of Research and Development (HTN-95-00726) Copyright

LIDAR data of stratospheric aerosol layers from the Mount Pinatubo eruption, taken on long range flights with a Transall aircraft, have been investigated to study the exchange of air-masses across the polar vortex boundary. From these measurements we found that the center region of the stratospheric polar vortex was free of volcanic aerosol above PT values of 485 K throughout the whole winter, with the exception of small isolated clouds appearing at the end of Jan. 92. Below 420 K the aerosol layers are very homogeneous on an isentropic surface and do not show much correlation with the vortex. Author (Hemer)

A95-86308

AIRBORNE LIDAR OBSERVATION OF MOUNTAIN-WAVE-INDUCED POLAR STRATOSPHERIC CLOUDS DURING EASOE

S. GODIN Universite Pierre et Marie Curie, France, G. MEGIE Universite Pierre et Marie Curie, France, C. DAVID Universite Pierre et Marie Curie, France, D. HANER Universite Pierre et Marie Curie, France, C. FLESIA Observatoire de Neuchatel, Switzerland, and Y. EMERY Observatoire de Neuchatel, Switzerland Geophysical Research Letters (ISSN 0094-8276) vol. 21, no. 13 June 22, 1994 p. 1335-1338 Research supported by the French Middle Atmosphere Programme (Contract(s)/Grant(s): CEC-STEP-CT91-040) (HTN-95-00738) Copyright

The airborne backscatter lidar Leandre was flown during the European Arctic Ozone Stratospheric Experiment (EASOE) campaign on board the French ARAT-Fokker 27, to provide mesoscale observations of scattering layers in the stratosphere. The use of cross-polarization channels at the 532 nm laser emitted wavelength, allowed discrimination between the quasi-spherical particles of the

Pinatubo aerosol and the non-spherical frozen particles of polar stratospheric clouds. Measurements taken on December 11, 1991 revealed mountain-wave-induced polar stratospheric clouds at 21 km altitude, extending over 300 km west and 300 km east from Kiranu. The wavelength and amplitude of the perturbation imply local cooling ranging from 3 deg K to 10 deg K in the stratosphere, taking the temperature below the threshold of formation of polar stratospheric clouds. Author (Hemer)

A95-86312

AIRBORNE MEASUREMENTS DURING THE EUROPEAN ARCTIC STRATOSPHERIC OZONE EXPERIMENT COLUMN AMOUNTS OF HNO₃ AND O₃ DERIVED FROM FTIR EMISSION SOUNDING

C. E. BLOM Universitaet Karlsruhe, Germany, H. FISCHER Universitaet Karlsruhe, Germany, N. GLATTHOR Universitaet Karlsruhe, Germany, T. GULDE Universitaet Karlsruhe, Germany, and M. HOPFNER Universitaet Karlsruhe, Germany Geophysical Research Letters (ISSN 0094-8276) vol. 21, no. 13 June 22, 1994 p. 1351-1354 Research supported by the German Federal Ministry for Research and Technology (Contract(s)/Grant(s): CEC-STEP-CT91-0140) (HTN-95-00742) Copyright

During EASOE (European Arctic Stratospheric Ozone Experiment) winter campaign 1991/92, first measurements were made from an aircraft with the new atmospheric sounder MIPAS-FT (Michelson Interferometer for Passive Atmospheric Sounding-Flugzeug Transall). The instrument measures infrared radiation emitted by atmospheric trace constituents in the spectral range between 750 and 1250/cm. As first results, we present zenith column amounts of O₃ and HNO₃ retrieved from data recorded between January 30 and February 16, 1992 in the region from 45 deg west to 45 deg east and from 55 deg to 80 deg north. The column amounts vary considerably, from 1 to 3 x 10¹⁶ molecules/sq cm for HNO₃ and from 180 to 420 dobson units for O₃, respectively. The strong linear correlation between these stratospheric gases indicates that the large variations during that period are mainly due to dynamic processes in the arctic atmosphere. Author (Hemer)

A95-86315

AIRBORNE MEASUREMENTS DURING THE EUROPEAN ARCTIC STRATOSPHERIC OZONE EXPERIMENT : OBSERVATION OF OCIO

RONALD BRANDTJEN Max-Planck-Institut fuer Chemie, Mainz, Germany, T. KLUPFEL Max-Planck-Institut fuer Chemie, Mainz, Germany, D. PERNER Max-Planck-Institut fuer Chemie, Mainz, Germany, and B. M. KNUDSEN Danish Meteorological Institute, Copenhagen, Denmark Geophysical Research Letters (ISSN 0094-8276) vol. 21, no. 13 June 22, 1994 p. 1363-1366 Research supported by the Bundesministerium fuer Forschung und Technologie (Contract(s)/Grant(s): CEC-STEP-CT91-0140) (HTN-95-00745) Copyright

Within the European Arctic Stratospheric Ozone Experiment (EASOE) 1991/92, airborne UV-VIS spectral measurements of stratospheric OCIO, NO₂, and O₃ were made by DOAS (Differential Optical Absorption Spectroscopy). The TRANSALL C160 was operated for the observation of the polar stratosphere from Kiranu (67 deg N), Sweden, during four campaigns from December 1991 to March 1992. Inside the vortex, the highest vertical column densities of OCIO, up to 12 x 10¹² molecules/sq cm at a solar zenith angle of 90 deg, were observed during January and February 1992. The last OCIO was detected on March 11 (4 x 10¹² molecules/sq cm). Cross sections of the vortex showed the largest amounts of OCIO within the core and lesser amounts in the vortex boundary. OCIO was not detected outside the vortex within the detection limit which was 5 x 10¹² molecules/sq cm in December 1991 and about 2.5 x 10¹² molecules/sq cm in spring 1992. Author (Hemer)

A95-86318

AIRBORNE MEASUREMENTS DURING THE ARCTIC

STRATOSPHERIC EXPERIMENT: OBSERVATION OF O₃ AND NO₂

K. PFEILSTICKER University of Heidelberg, Germany and U. PLATT University of Heidelberg, Germany Geophysical Research Letters (ISSN 0094-8276) vol. 21, no. 13 June 22, 1994 p. 1375-1378 (Contract(s)/Grant(s): CEC-STEP-CT91-0140; BMFT-01VOZ28A7) (HTN-95-00748) Copyright

During winter 1991/92 DOAS (Differential Optical Absorption Spectroscopy) measurements were performed from a C130 Transall aircraft within the framework of the EASOE (European Arctic Stratospheric Ozone Experiment) campaign. The campaign extended from Dec. 1991 until March 1992 with a series of flights in the Arctic (60 deg W to 60 deg E, 85 deg N to 48 deg N). Two spectrometers were operated on the aircraft: an UV-instrument (see Brandtjen et al., this issue) and a DOAS-vis instrument to detect O₃, O₄, NO₂, and NO₃ in the visible band (363 nm-680 nm). The DOAS-vis ozone measurements were largely influenced by the presence of the Mt Pinatubo aerosol cloud. A correction of the data by actual Mie-profiles is described. A NO₂ depletion with minimum values of 2.3 x 10¹⁴ (exp 14)/sq cm in Jan. 92 was observed. Occasionally, OCIO could also be detected. Author (Hemer)

N95-26453 Federal Aviation Administration, Atlanta, GA. Technical Center.

WEATHER AND RADAR PROCESSOR (WARP) TEST AND EVALUATION MASTER PLAN (TEMP)

WILLIAM BENNER, CHRISTOPHER MALITSKY, WILLIAM HALL, and MATTHEW PRINTY Oct. 1994 129 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A288280; DOT/FAA/CT-TN94/36) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This Test and Evaluation Master Plan (TEMP) describes the Test and Evaluation (T&E) processes which will be used to ensure the Weather and Radar Processor (WARP) system meets the requirements allocated to the project in the NAS-SS-1000, volumes 1, 2, and 5, the NAS-SR-1000, and the WARP System Specification, FAA-E-To Be Determined (TBD). This TEMP defines test strategy, test requirements, and organizational roles and responsibilities and is developed in accordance with Federal Aviation Administration (FAA) Order 1810.4B and FAA-STD-O24a. This version of the TEMP addresses the testing requirements for the first two stages of WARP. This TEMP will be updated with additional detail when the WARP program Stage 1, 2, and 3 NAS Change Proposals (NCP) are developed and as the program progresses through the KDP 3 and KDP 4 phases. The original TEMP and its revisions will be submitted for approval by the Test Policy Rules Committee (TPRC). A WARP system will be deployed in all Air Route Traffic Control Centers (ARTCC) and at the Air Traffic Control System Command Center (ATCSCC). It is a Non-developmental Item (NDI)-based automated interactive meteorological data and information processing service that will serve as the primary source of real-time tactical and strategic weather data for air traffic controllers, traffic management unit (TMU) coordinators and area supervisors, meteorologists, and pilots. The WARP system will provide real-time mosaicked WSR-88D products to the air traffic controllers. DTIC

N95-26669*# Desert Research Inst., Reno, NV. Atmospheric Sciences Center.

REPLICATOR FOR CHARACTERIZATION OF CIRRUS AND POLAR STRATOSPHERIC CLOUD PARTICLES Final Report JOHN HALLETT and RICHARD G. PURCELL Mar. 1995 17 p (Contract(s)/Grant(s): NAG2-663)

(NASA-CR-197785; NAS 1.26:197785) Avail: CASI HC A03/MF A01

A formvar replicator for installation in an aircraft pod has been designed, built, and flight tested on the NASA DC-8. The system incorporates a deicing capability (which can be pressure activated) to enable climb out through icing situations prior to deployment. The system can be operated at preselected speeds such that data can

13 GEOSCIENCES

be recorded over a period of 1 to ten hours on 200 ft of 16mm film. A x2 speed control can be used during flight. Capability exists for detection of chemical constituents by appropriate doping of formvar solution.

Author

**N95-26841 Naval Air Systems Command, Arlington, VA.
NAVAL AVIATION SYSTEM TEAM MAPPING, CHARTING,
AND GEODESY HANDBOOK Final Report**

JOHN H. HARDEN, JR. and ZDENKA S. WILLIS 15 Jul. 1994 70 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A288590) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This handbook is specifically tailored for Naval Aviation Systems Team (TEAM) weapon systems developers. It is a primary reference for information about Mapping, Charting, and Geodesy (MC&G) support from the Defense Mapping Agency (DMA). Handbook objectives are: (1) to clarify MC&G relevance to TEAM systems development and the developer's job; (2) to guide developers in acquiring a necessary basic competence in MC&G; (3) to explain the process for getting DMA MC&G data and services; and (4) to point developers towards helping on MC&G issues within the TEAM, DMA, and elsewhere. The Handbook has the following features: (1) it is organized for browsing; (2) the Executive Gouge summarizes everything on one page; (3) details to access topical sources are located in the Where To Find It box at the end of each section; and (4) useful appendices include product statistics and list key individuals. After initial hard copy distribution, this handbook will be maintained in soft copy on the Naval Air Systems Command (NAVAIR) Headquarters Network (NHN).

DTIC

**N95-26858 Naval Postgraduate School, Monterey, CA.
A MATHEMATICAL ANALYSIS OF THE JANUS COMBAT
SIMULATION WEATHER EFFECTS MODELS AND
SENSITIVITY ANALYSIS OF SKY-TO-GROUND
BRIGHTNESS RATIO ON TARGET DETECTION M.S. Thesis**

VINCIENT F. SHORTS Sep. 1994 80 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A289629) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The Janus combat simulation offers the user a wide variety of weather effects options to employ during the execution of any simulation run, which can directly influence detection of opposing forces. Realistic weather effects are required if the simulation is to accurately reproduce 'real world' results. This thesis examines the mathematics of the Janus weather effects models. A weather effect option in Janus is the sky-to-ground brightness ratio (SGR). SGR affects an optical sensor's ability to detect targets. It is a measure of the sun angle in relation to the horizon. A review of the derivation of SGR is performed and an analysis of SGR's effect on the number of optical detections and detection ranges is performed using an unmanned aerial vehicle (UAV) search scenario. For comparison, the UAV's are equipped with a combination of optical and thermal sensors.

DTIC

**N95-27156 National Academy of Sciences - National Research
Council, Washington, DC. Committee on Geodesy.
AIRBORNE GEOPHYSICS AND PRECISE POSITIONING:
SCIENTIFIC ISSUES AND FUTURE DIRECTIONS**

1995 119 p
(LC-94-68678; ISBN-0-309-05183-5) Copyright Avail: Issuing Activity (NAS-NRC)

Since the Challenger circumnavigated the globe on its oceanographic survey in the mid-1870's, scientists have mounted extensive interdisciplinary expeditions to study large regions of the Earth. The ability to probe the Earth from remote platforms has resulted in numerous scientific advances, such as the revolutionary images of previously uncharted ocean floor that were produced by marine geophysical technology in the 1960s. These images eventually helped to trigger a major paradigm shift in the earth sciences with the

development of a fundamental theory of modern geophysics, plate tectonics. The purpose of this report is to highlight the advances, both potential and realized, that airborne geophysics and precise positioning have made or can make possible to the solid earth sciences. The report first discusses the state of the art in airborne geophysics as integrated with new precise positioning systems, focusing first on the new technology to map topography and the gravity field and then on recent advances in precise positioning. The scientific goals of a focused effort in airborne geophysics, including advances in our understanding of solid earth science, global climate change, the environment, and resources are outlined. The technological advances in measurement, positioning, and aircraft design that will be required to aggressively pursue the scientific goals discussed previously are identified. The recommendations of the Committee on Geodesy for achieving the goals and directions outlined in the report are presented.

Derived from text

**N95-27234# Radian Corp., Austin, TX.
COMMUNITY RELATIONS PLAN: GALENA AIRPORT AND
CAMP ION AIR FORCE STATION, ALASKA Final Report**

11 Nov. 1994 55 p
(Contract(s)/Grant(s): F33615-90-D-4013)
(AD-A286722; RAD-93-269-107-12-01) Avail: CASI HC A04/MF A01

The U.S. Air Force has been designated as the lead government agency in cleanup efforts at Galena Airport and Campion Air Force Station, Alaska. This community relations plan (CRP) is consistent with federal guidance for community relations efforts and satisfies the policies established for Superfund remedial activities by the EPA, under direction of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. The objectives of the CRP are to: Assess community concerns regarding planned and ongoing studies, and determine how and when the public would like to be involved in the decision-making process; Establish procedures for accurate and timely release of information to potentially affected and interested citizen groups, elected officials, public interest groups, agency officials, and the media; Establish methods to facilitate communication between the Air Force and the community at large; Articulate and clarify key issues for the public; Be responsive to the needs and concerns of public interest groups, agency officials, and the media; Receive and understand all the information that the various interest groups have to communicate; and Search for a consensus of the decisions that are being developed throughout the process.

DTIC

**N95-27459# National Renewable Energy Lab., Golden, CO.
A COMPARISON OF MEASURED WIND PARK LOAD
HISTORIES WITH THE WISPER AND WISPERX LOAD
SPECTRA**

N. D. KELLEY Jan. 1995 8 p Presented at the 1995 American Society of Mechanical Engineers (ASME) Energy Sources Technology Conference and Exhibition, Houston, TX, 29 Jan. - 1 Feb. 1995
(Contract(s)/Grant(s): DE-AC36-83CH-10093)
(DE95-000295; NREL/TP-442-7226; CONF-950116-6) Avail: CASI HC A02/MF A01

The blade-loading histories from two adjacent Micon 65/13 wind turbines are compared with the variable-amplitude test-loading histories known as the WISPER and WISPERX spectra. These standardized loading sequences were developed from blade flapwise load histories taken from nine different horizontal-axis wind turbines operating under a wide range of conditions in Europe. The subject turbines covered a broad spectrum of rotor diameters, materials, and operating environments. The final loading sequences were developed as a joint effort of thirteen different European organizations. The goal was to develop a meaningful loading standard for horizontal-axis wind turbine blades that represents common interaction effects seen in service. In 1990, NREL made extensive load measurements on two adjacent Micon 65/13 wind turbines in simultaneous operation in the very turbulent environment of a large wind park. Further, before and during the collection of the loads data,

comprehensive measurements of the statistics of the turbulent environment were obtained at both the turbines under test and at two other locations within the park. The trend to larger but lighter wind turbine structures has made an understanding of the expected lifetime loading history of paramount importance. Experience in the US has shown that the turbulence-induced loads associated with multi-row wind parks in general are much more severe than for turbines operating individually or within widely spaced environments. Multi-row wind parks are much more common in the US than in Europe. In this paper we report on our results in applying the methodology utilized to develop the WISPER and WISPERX standardized loading sequences using the available data from the Micon turbines. While the intended purpose of the WISPER sequences were not to represent a specific operating environment, we believe the exercise is useful, especially when a turbine design is likely to be installed in a multi-row wind park. DOE

N95-27805* Lamont-Doherty Geological Observatory, Palisades, NY.

AN IN SITU EVALUATION OF TOPEX/POSEIDON ALTIMETRIC MEASUREMENTS VERSUS MEASUREMENTS MADE BY MOORINGS AND INVERTED ECHO SOUNDERS FOR SEA SURFACE HEIGHT Final Report

1994 25 p

(Contract(s)/Grant(s): NAG5-2058; JPL-958123)

(NASA-CR-198621; NAS 1.26:198621) Avail: CASI HC A03/MF A01

The classical method of observing the sea surface height has been to make shipboard measurements of the vertical - density profile, and then calculating the surface height relative to a deeper reference surface. Two methods (a moored vertical string of instruments and an inverted echo sounder) were subsequently developed to obtain longer time in situ measurements. The first of these can be thought of as an extension of the discrete bottle hydrocast while the second integrates acoustically over the water column. One purpose of this note is to compare the result when coincidental observations are made by these two methods. This was done at two sites in the western tropical Pacific. Two inverted echo sounders were deployed alongside two enhanced TOGA-COARE moorings to be used in an in situ evaluation of TOPEX/Poseidon altimetric measurements of sea surface height. The mooring and inverted echo sounder data reproduced one another, at low frequency, with a correlation of 0.93 and 0.95 and the altimeter correlated with each of the above values ranging from 0.84 to 0.94. It is concluded that the altimetric measurements are statistically equivalent to the in situ measurements in the area of study. Derived from text

N95-27970* DASCONE Engineering, Bay Village, OH.
COLLECTED PAPERS ON WIND TURBINE TECHNOLOGY

DAVID A. SPERA, ed. May 1995 236 p

(Contract(s)/Grant(s): NAS3-25776; RTOP 776-33-41; DE-AI01-76ET-20320)

(NASA-CR-195432; E-9439; NAS 1.26:195432; DOE/NASA/5776-2) Avail: CASI HC A11/MF A03

R and D projects on electricity generating wind turbines were conducted at the NASA Lewis Research Center from 1973 to 1988. Most projects were sponsored by the U.S. Department of Energy (DOE), a major element of its Federal Wind Energy Program. Another large wind turbine project was by the Bureau of Reclamation of the U.S. Department of Interior (DOI). From 1988 to 1995, NASA wind energy activities have been directed toward the transfer of technology to commercial and academic organizations. As part of these technology transfer activities, previously unpublished manuscripts have been assembled and presented here to share the wind turbine research results with the wind energy community. A variety of wind turbine technology topics are discussed: Wind and wake models; Airfoil properties; Structural analysis and testing; Control systems; Variable speed generators; and acoustic noise. Experimental and theoretical results are discussed. For individual titles, see N95-27971 through N95-27992.

15

MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A95-82449

NONLINEAR OBSERVER AND ITS APPLICATION IN FLIGHT CONTROL

YU YAO Harbin Institute of Technology, China, ZICAI WANG Harbin Institute of Technology, China, JIAREN KANG Harbin Institute of Technology, China, and DEYUAN CHEN Harbin Institute of Technology, China In International Symposium on Space Technology and Science, 18th, Kagoshima, Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan ISTS Editorial Board 1992 p. 1021-1027

Copyright

The design of a variable structure observer of a nonlinear system and its application in flight control are developed. The design of variable structure observer is presented and developed, and its concrete form is also given. The equations of relative motion of the vehicle and target in the line-of-sight coordinates are established, and the nonlinear guidance law is given. For this engineering problem, unmeasurable physical quantities are contained in the guidance law and the design of a nonlinear state observer is given. It follows that the realizability of the nonlinear guidance law is ensured. Finally, the effectiveness of the state observer designed in the paper is proved by digital simulation. Author (Hemer)

A95-85675

SCHEDULING OF LOCAL NONLINEAR CONTROL LAWS BY EXOGENOUS SIGNALS - AN APPLICATION TO FLIGHT CONTROL

JIANLIANG WANG Nanyang Technological Univ, Nanyang, Singapore International Journal of Control (ISSN 0020-7179) vol. 61, no. 4 April 1995 p. 759-782 refs

(BTN-95-EIX95262694059) Copyright

A new scheduling technique is presented for scheduling local nonlinear control laws. This leads to a new nonlinear design method for regulation of flight control systems. First, nonlinear feedback controls are designed using a nonlinear optimal control design method at a number of operating points (i.e. different Mach numbers). Then these nonlinear control laws are scheduled in a particular way according to the forward speed u . The resulting control law still takes the form of a static nonlinear control and is such that deviation in forward speed u (the scheduling variable) from the trim value does not affect control of the short period variables. This nice property can be retained over the entire flight envelope. The well-studied F-8 aircraft is used for this study. Computer simulations are given to show the effectiveness of this nonlinear control design method. Robustness to variations in system parameters is also studied by simulation. Author (EI)

N95-26348 Naval Air Warfare Center, Warminster, PA. Aircraft Div.

AN EVALUATION OF THE SOFTWARE THROUGH PICTURES/T TOOL (STP/T) FOR THE SOFTWARE SUPPORT ACTIVITY (SSA) Final Report

VIRGIL BANOWETZ 28 Nov. 1994 135 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): N62269-90-C-0412)

(AD-A288822) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This study was conducted by the Naval Air Warfare Center Aircraft Division (NAWCADWAR) to evaluate the Interactive Development Environments (IDE) software product known as the T tool.

The evaluation was initiated at the request of NAVAIRSYSCOM AIR-54661 to determine the applicability of these tools to the SSA environment. The conduct of the evaluation spanned the time period from March 1994 through September 1994. A 'Plan for Testing the T tool for SSA' was presented to and approved by AIR-54661 in April, 1994. The T tool is a specification based test case generation tool. This means that a specification which describes the inputs and outputs of a process or module is the only basis for producing the test cases. T was previously evaluated by Christine Youngblut of the Institute for Defense Analysis (item h in Applicable Documents) who reported that StP/T is currently being used by various government organizations including the Naval Avionics Center, the Jet Propulsion Laboratories, Naval Coastal Systems Center and US. Army Forts Monmouth and Sill. DTIC

N95-26638 Galaxy Scientific Corp., Pleasantville, NJ.
DIGITAL SYSTEMS VALIDATION. CHAPTER 20 ARTIFICIAL INTELLIGENCE WITH APPLICATIONS FOR AIRCRAFT. HANDBOOK, VOLUME 2
L. HARRISON, P. SAUNDERS, and J. JANOWITZ Jul. 1994 200 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): DTFA03-89-C-00043)
(AD-A288492; DOT/FAA/CT-88/10-VOL-2) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This chapter provides an overview of Artificial Intelligence (AI) technology, one of the more complex applications of digital systems. This chapter examines AI-based technology, focusing on three fields: neural networks, 'fuzzy' logic, and Expert Systems. This chapter provides the reader with the background and a basic understanding of the fundamental at those fields. Another section examines aspects of the AI development environment, including languages, tools, and AI-based hardware components. Some of the proposed aviation-related applications for both civil and military aircraft, including pilot assistants and diagnostic aids, are surveyed. Additionally, certification issues, including regulations, guidelines, and verification and validation techniques are examined. Human factors issues relating to the use of this technology are identified and reviewed. In addition, this chapter identifies safety issues and concerns over the use of this technology in airborne systems. DTIC

N95-26648* MCAT Inst., San Jose, CA.
SUPERSONIC TRANSPORT GRID GENERATION, VALIDATION, AND OPTIMIZATION Final Report, 1993 - 31 Jan. 1995
PHILIP G. AARONSON Jan. 1995 15 p Original contains color illustrations
(Contract(s)/Grant(s): NCC2-522)
(NASA-CR-197752; NAS 1.26:197752; MCAT-95-03) Avail: CASI HC A03/MF A01; 1 functional color page

The ever present demand for reduced flight times has renewed interest in High Speed Civil Transports (HSCT). The need for an HSCT becomes especially apparent when the long distance, over-sea, high growth Pacific rim routes are considered. Crucial to any successful HSCT design are minimal environmental impact and economic viability. Vital is the transport's aerodynamic efficiency, ultimately effecting both the environmental impact and the operating cost. Optimization, including numerical optimization, coupled with the use of computational fluid dynamics (CFD) technology, has and will offer a significant improvement beyond traditional methods.

Derived from text

N95-26845 Honeywell, Inc., Minneapolis, MN. Systems and Research Div.
MICRO-TIME STRESS MEASUREMENT DEVICE DEVELOPMENT Final Report, Aug. 1989 - Jan. 1992
GARY HARVEY, STEVEN LOUIS, and STEVEN BUSKA Nov. 1994 88 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): F30602-89-D-0100)
(AD-A289511; RL-TR-94-196) Avail: Issuing Activity (Defense

Technical Information Center (DTIC))

This report describes the Micro-Time Stress Measurement Device (TSMD) developed and delivered under this contract. The Micro-TSMD is a microprocessor controlled device to read the installed environmental sensors and record their results in a non-volatile memory. It is contained in a hybrid package about 1 x 1.8 x 0.2 (inches), weighing less than an ounce. The TSMD contains sensors for temperature, mechanical vibration/shock, and DC voltage monitoring, including transients, and may be connected to external sensors. It requires external power. DTIC

N95-26895 Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
EASY-SIM: A VISUAL SIMULATION SYSTEM SOFTWARE ARCHITECTURE WITH AN ADA 9X APPLICATION FRAMEWORK M.S. Thesis
JORDAN R. KAYLOE Dec. 1994 162 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A289325; AFIT/GCS/ENG/94D-11) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Software architectures increase productivity when used as the basis for developing applications in a problem domain. This thesis describes the creation of Easy-Sim, an object-oriented software architecture for visual simulation systems, and its corresponding implementation as an application framework in Ada 9X. The research built upon ObjectSim, an existing object-oriented simulation architecture implemented as an application framework. Both ObjectSim and Easy-Sim operate on Silicon Graphics platforms and use the IRIS Performer graphics programming library. Easy-Sim is implemented using version 1.83 of the GNAT compiler. The investigation for this thesis involved honing ObjectSim's design, implementing the improved result in both C++ and Ada 9X, and developing applications to compare the two versions. The study achieved two main objectives: producing Easy-Sim as an improved visual simulation system architecture by building on ObjectSim's experience, and producing a visual simulation system application from Easy-Sim in Ada 9X that performs at a level comparable to the same application built in C++. DTIC

N95-26920 Air Force Inst. of Tech., Wright-Patterson AFB, OH.
A GAIN SCHEDULING OPTIMIZATION METHOD USING GENETIC ALGORITHMS M.S. Thesis
ROBERT C. MARTIN, IV Dec. 1994 153 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A289306; AFIT/GAE/ENY/94D-3) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Gain scheduling, the traditional method of providing adaptive control to a nonlinear system, has long been an ad hoc design process. Until recently, little theoretical guidance directed these practitioners' art. For this reason a systematic study of this design process and its potential for optimization has never been accomplished. Additionally, the nonlinearities and the large search space involved in gain scheduling also precluded such an optimization study. Traditionally, the gain scheduling process has been some variation of a linear interpolation between discrete design points. By using powerful non-traditional optimization tools such as genetic algorithms there are ways of improving this design process. This thesis utilizes the power of genetic algorithms to optimally design a gain schedule. First, a design methodology is validated on a simple pole placement problem, then demonstrated for an F-18 Super-maneuverable Fighter. From this experience, a general gain scheduling design process is developed and presented. DTIC

N95-26943# Wichita State Univ., Wichita, KS.
AN EXPLORATORY APPLICATION OF NEURAL NETWORKS FOR AIRFOIL DESIGN Abstract Only
STEVE HUANG, L. S. MILLER, and J. E. STECK In its AIAA Techfest 20 Proceedings 26 p 1994
Avail: CASI HC A03/MF A03

This document reports the use of artificial neural networks

(A.N.N.) for airfoil design, and it focuses on the following sections: (1) Investigative goals — to develop an inverse airfoil design method using A.N.N. for single element airfoils and using experience to determine the possibility of using A.N.N. for multi-element airfoil design; (2) Airfoil design methods — iterative method and inverse method; (3) Artificial neural network — method to solve complex non-linear problems (image processing, speech recognition, adaptive control, and airfoil performance analysis), highly parallel computational devices, can be trained to learn a set of input/output patterns, able to generalize outside its training domain, and usually implemented using a software package which simulates the parallel architecture; (4) Training data — utilize eppel code to generate training data, symmetric airfoil sections, reynolds number, thickness to chord ratios, and pressure recovery points; and (5) Results, Conclusions, and Recommendations. CASI

N95-26990 Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

SURVEY AND IMPLEMENTATION OF COMMERCIAL MANUAL CONTROLLERS FOR A GENERIC TELEROBOTICS ARCHITECTURE M.S. Thesis

THOMAS E. DEETER Dec. 1994 128 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(AD-A289215; AFIT/GE/ENG/94D-04) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The purpose of this study is to determine an input device for the Air Force's generic telerobotics architecture for large aircraft maintenance and repair. One area of concern is the human to machine interface, more specifically, which manual controller should be used for the specified tasks in this architecture. The authors mailed a survey to 68 companies in order to compile a list of possible input devices that the telerobotics architecture could use. Thirty-two companies responded which gave enough data to generate a list that described the physical traits of the input devices. The required tasks were divided into actions and analyzed to generate a list of traits required by an input device. Both the task analysis and device listings were combined mathematically to form a performance table which revealed the possible devices that could perform each individual action. To aid in development of the Air Force's generic telerobotics architecture, four input devices were integrated into a VME based operating system called CHIMERA. These four devices represent the four different sensor types that are currently available in today's market. The first device is a mouse which relays position changes of the mouse to the computer. The second device is a joystick that can be used in two different ways. The joystick can measure position data of the hand position or it can measure the displacement of the hand from the center of the total movement. The third device is a six degree-of-freedom (DOF) spaceball that measures the amount of force for position data and rotational data. The fourth device is a Schilling manual controller which has a one-to-one mapping from the controller joints to the manipulator joints. DTIC

N95-27241* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A STUDY OF WORKSTATION COMPUTATIONAL PERFORMANCE FOR REAL-TIME FLIGHT SIMULATION

JEFFREY M. MADDALON and JEFF I. CLEVELAND, II Feb. 1995 10 p

(Contract(s)/Grant(s): RTOP 505-90-53-02)

(NASA-TM-109184; NAS 1.15:109184) Avail: CASI HC A02/MF A01

With recent advances in microprocessor technology, some have suggested that modern workstations provide enough computational power to properly operate a real-time simulation. This paper presents the results of a computational benchmark, based on actual real-time flight simulation code used at Langley Research Center, which was executed on various workstation-class machines. The benchmark was executed on different machines from several companies including: CONVEX Computer Corporation, Cray Research, Digital Equipment Corporation, Hewlett-Packard, Intel, International Business Machines, Silicon Graphics, and Sun Microsystems. The machines

are compared by their execution speed, computational accuracy, and porting effort. The results of this study show that the raw computational power needed for real-time simulation is now offered by workstations. Author

N95-27246* Loral Federal Systems, Manassas, VA.

ADVANCED FLIGHT COMPUTER. SPECIAL STUDY Final Report, Apr. 1994 - Feb. 1995

DENNIS COO Mar. 1995 54 p

(Contract(s)/Grant(s): NASA ORDER L-40679-D; RTOP 233-01-03-23; F29601-89-C-0089)

(NASA-CR-198165; NAS 1.26:198165) Avail: CASI HC A04/MF A01

This report documents a special study to define a 32-bit radiation hardened, SEU tolerant flight computer architecture, and to investigate current or near-term technologies and development efforts that contribute to the Advanced Flight Computer (AFC) design and development. An AFC processing node architecture is defined. Each node may consist of a multi-chip processor as needed. The modular, building block approach uses VLSI technology and packaging methods that demonstrate a feasible AFC module in 1998 that meets that AFC goals. The defined architecture and approach demonstrate a clear low-risk, low-cost path to the 1998 production goal, with intermediate prototypes in 1996. Author

N95-27914* National Aeronautics and Space Administration. Flight Research Center, Edwards, CA.

NASA DRYDEN FLOW VISUALIZATION FACILITY

JOHN H. DELFRATE Washington May 1995 29 p Original contains color illustrations

(Contract(s)/Grant(s): RTOP 505-59-53)

(NASA-TM-4631; H-1972; NAS 1.15:4631) Avail: CASI HC A03/MF A01; 4 functional color pages

This report describes the Flow Visualization Facility at NASA Dryden Flight Research Center, Edwards, California. This water tunnel facility is used primarily for visualizing and analyzing vortical flows on aircraft models and other shapes at high-incidence angles. The tunnel is used extensively as a low-cost, diagnostic tool to help engineers understand complex flows over aircraft and other full-scale vehicles. The facility consists primarily of a closed-circuit water tunnel with a 16- x 24-in. vertical test section. Velocity of the flow through the test section can be varied from 0 to 10 in/sec; however, 3 in/sec provides optimum velocity for the majority of flow visualization applications. This velocity corresponds to a unit Reynolds number of 23,000/ft and a turbulence level over the majority of the test section below 0.5 percent. Flow visualization techniques described here include the dye tracer, laser light sheet, and shadowgraph. Limited correlation to full-scale flight data is shown. Author

N95-27979* Paragon Pacific, Inc., El Segundo, CA.

DESIGN OF A REAL-TIME WIND TURBINE SIMULATOR USING A CUSTOM PARALLEL ARCHITECTURE

JOHN A. HOFFMAN, R. GLUCK (TRW Space Technology Labs., Redondo Beach, CA.), and S. SRIDHAR (TRW Space Technology Labs., Redondo Beach, CA.) In DASCON Engineering, Collected Papers on Wind Turbine Technology p 79-87 May 1995 Sponsored by DOE

Avail: CASI HC A02/MF A03

The design of a new parallel-processing digital simulator is described. The new simulator has been developed specifically for analysis of wind energy systems in real time. The new processor has been named: the Wind Energy System Time-domain simulator, version 3 (WEST-3). Like previous WEST versions, WEST-3 performs many computations in parallel. The modules in WEST-3 are pure digital processors, however. These digital processors can be programmed individually and operated in concert to achieve real-time simulation of wind turbine systems. Because of this programmability, WEST-3 is very much more flexible and general than its two predecessors. The design features of WEST-3 are described to show how the system produces high-speed solutions of nonlinear time-domain equations. WEST-3 has two very fast Computational

Units (CU's) that use minicomputer technology plus special architectural features that make them many times faster than a microcomputer. These CU's are needed to perform the complex computations associated with the wind turbine rotor system in real time. The parallel architecture of the CU causes several tasks to be done in each cycle, including an IO operation and the combination of a multiply, add, and store. The WEST-3 simulator can be expanded at any time for additional computational power. This is possible because the CU's interfaced to each other and to other portions of the simulation using special serial buses. These buses can be 'patched' together in essentially any configuration (in a manner very similar to the programming methods used in analog computation) to balance the input/output requirements. CU's can be added in any number to share a given computational load. This flexible bus feature is very different from many other parallel processors which usually have a throughput limit because of rigid bus architecture.

Author

**N95-28335 Naval Surface Warfare Center, Dahlgren, VA.
PARALLEL BLOCK IMPLICIT INTEGRATION TECHNIQUE
FOR TRAJECTORY PARALLELISM**

ALAN E. RUFTY Dec. 1994 39 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (AD-A288961; NSWCDD/TR-94/217) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This report describes the evaluation of a Parallel Block Implicit (PBI) integration technique in a simplified missile trajectory. This project was carried out to ascertain the suitability of PBI techniques when modest amounts of parallelism are available; that is, when 3 to 10 processors are allocated per missile trajectory. The PBI technique was first evaluated on a serial mainframe computer before it was implemented in parallel on an INMOS TRANSPUTER with four parallel central processing units. While the serial implementation of the four-node PBI technique indicated that a speedup of a factor of three to four was possible with ideal hardware, in practice only a modest gain (approximately 30 percent) was obtained because of systems-related overhead.

DTIC

N95-28627* Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.

**SOFTWARE PROCESS IMPROVEMENT IN THE NASA
SOFTWARE ENGINEERING LABORATORY Final Technical
Report**

FRANK MCGARRY (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.), ROSE PAJERSKI (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.), GERALD PAGE (Computer Sciences Corp., Greenbelt, MD.), SHARON WALIGORA (Computer Sciences Corp., Greenbelt, MD.), VICTOR BASILI (Maryland Univ., College Park, MD.), and MARVIN ZELKOWITZ (Maryland Univ., College Park, MD.) Dec. 1994 79 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (Contract(s)/Grant(s): F19628-90-C-0003)

(AD-A289912; CMU/SEI-94-TR-22; ESC-TR-94-022) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The Software Engineering Laboratory (SEL) was established in 1976 for the purpose of studying and measuring software processes with the intent of identifying improvements that could be applied to the production of ground support software within the Flight Dynamics Division (FDD) at the National Aeronautics and Space Administration (NASA)/Goddard Space Flight Center (GSFC). The SEL has three member organizations: NASA/GSFC, the University of Maryland, and Computer Sciences Corporation (CSC). The concept of process improvement within the SEL focuses on the continual understanding of both process and product as well as goal-driven experimentation and analysis of process change within a production environment.

DTIC

16 PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

A95-82176

**PERMANENT MAGNET ELECTRON CYCLOTRON
RESONANCE PLASMA SOURCE WITH REMOTE WINDOW**

LEE A. BERRY Oak Ridge Natl Lab, Oak Ridge, TN, United States and S. M. GORBATKIN Journal of Vacuum Science & Technology A: Vacuum, Surfaces, and Films (ISSN 0734-2101) vol. 13, no. 2 March-April 1995 p. 343-348 refs (BTN-95-EIX95242674338) Copyright

An electron cyclotron resonance (ECR) plasma has been used in conjunction with a solid metal sputter target for Cu deposition over 200 mm diameters. The goal is to develop a deposition system and process suitable for filling submicron, high-aspect ratio ULSI features. The system uses a permanent magnet for creation of the magnetic field necessary for ECR, and is significantly more compact than systems equipped with electromagnets. A custom launcher design allows remote microwave injection with the microwave entrance window shielded from the copper flux. When microwaves are introduced at an angle with respect to the plasma, high electron densities can be produced with a plasma frequency significantly greater than the electron cyclotron frequency. Copper deposition rates of 1000 angstrom/min have been achieved.

Author (EI)

A95-82251

**TIME-DOMAIN IMAGING OF AIRBORNE TARGETS USING
ULTRA-WIDEBAND OR SHORT-PULSE RADAR**

E. J. ROTHWELL Michigan State Univ, East Lansing, MI, United States, K. M. CHEN, D. P. NYQUIST, and J. E. ROSS IEEE Transactions on Antennas and Propagation (ISSN 0018-926X) vol. 43, no. 3 March 1995 p. 327-329 refs (BTN-95-EIX95242673673) Copyright

A time-domain physical optics inverse scattering identity is derived for real-time use in ultra-wideband radar systems. It is shown that using the band-limited impulse response of a radar target provides an edge-enhanced image. A simulation based on stepped-frequency, multi-aspect measurements of aircraft models produces clear images with highly-defined edges.

Author (EI)

A95-85002

**A MODEL FOR TEMPERATURE-DEPENDENT COLLISIONAL
QUENCHING OF OH A(SUP 2) SIGMA(SUP +)**

P. H. PAUL Sandia National Laboratories, Livermore, CA, US Journal of Quantitative Spectroscopy & Radiative Transfer (ISSN 0022-4073) vol. 51, no. 3 March 1994 p. 511-524 Research sponsored by the U.S. Department of Energy (HTN-95-42308) Copyright

A model for the temperature-dependent collisional quenching of OH A(sup 2) Sigma(sup +) is presented. The model for quenching is based on a classical electron transfer mechanism. Predictions of the model are shown to adequately reproduce many of the experimentally observed trends: variation with collision partner, temperature, and vibrational level in OH A(sup 2) Sigma(sup +), and the disposition of the quenching products. A negligibly small electronic quenching cross-section is predicted for collision partners having positive ions that cannot be produced through a thermal collision with OH A(sup 2) Sigma(sup +). Results of the model are compared to experimentally measured cross-sections for a number of species of interest in combustion and aerothermodynamic applications. A general function for the temperature dependence of the cross-section for collisional quenching of OH A(sup 2) Sigma(sup +) is derived. Curve-fitting coefficients for a number of collision partners are tabulated.

Author (Hemer)

N95-26392* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AIRCRAFT NOISE PREDICTION PROGRAM THEORETICAL MANUAL: ROTORCRAFT SYSTEM NOISE PREDICTION SYSTEM (ROTONET), PART 4

DONALD S. WEIR (Lockheed Engineering and Sciences Co., Hampton, VA.), STEPHEN J. JUMPER (Lockheed Engineering and Sciences Co., Hampton, VA.), CASEY L. BURLEY (Lockheed Engineering and Sciences Co., Hampton, VA.), and ROBERT A. GOLUB Apr. 1995 270 p

(Contract(s)/Grant(s): RTOP 532-06-37-01)

(NASA-TM-83199-PT-4; L-16700-PT-4; NAS 1.15:83199-PT-4) Avail: CASI HC A12/MF A03

This document describes the theoretical methods used in the rotorcraft noise prediction system (ROTONET), which is a part of the NASA Aircraft Noise Prediction Program (ANOPP). The ANOPP code consists of an executive, database manager, and prediction modules for jet engine, propeller, and rotor noise. The ROTONET subsystem contains modules for the prediction of rotor airloads and performance with momentum theory and prescribed wake aerodynamics, rotor tone noise with compact chordwise and full-surface solutions to the Flowcs-Williams-Hawkings equations, semiempirical airfoil broadband noise, and turbulence ingestion broadband noise. Flight dynamics, atmosphere propagation, and noise metric calculations are covered in NASA TM-83199, Parts 1, 2, and 3. Author

N95-26801* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

SUPERSONIC COAXIAL JET NOISE PREDICTIONS

MILO D. DAHL and PHILIP J. MORRIS (Pennsylvania State Univ., University Park, PA.) May 1995 12 p Presented at the First Joint Aeroacoustics Conference, Munich, Germany, 12-15 Jun. 1995; sponsored by CEAS and AIAA

(Contract(s)/Grant(s): RTOP 505-62-52)

(NASA-TM-106917; E-9584; NAS 1.15:106917; CEAS/AIAA-95-171) Avail: CASI HC A03/MF A01

Predictions are made for the noise radiation from supersonic, coaxial jets. These predictions are based on the assumption that the noise radiation in the downstream direction of supersonic jets is dominated by sound generated by instability waves with supersonic phase velocities relative to ambient. Since the analysis requires a known mean flow and the coaxial jet mean flow is not described easily in terms of analytical functions, a numerical prediction is made for its development. The compressible, Reynolds averaged, boundary layer equations are solved with a modified mixing length turbulence model. The model has been calibrated to account for compressibility and temperature effects on the rate of mixing. Both normal and inverted velocity profile jets are considered. Predictions are made for the differences between the noise radiated by coaxial jets with difference operating conditions and a single reference jet with the same thrust, mass flow, and exit area. The effects of area ratio changes and simulated enhanced mixing on noise radiation are also considered. Author

N95-27908* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A NUMERICAL STUDY OF FUNDAMENTAL SHOCK NOISE MECHANISMS Ph.D. Thesis - Cornell Univ.

KRISTINE R. MEADOWS May 1995 193 p Original contains color illustrations

(NASA-TM-110608; NAS 1.15:110608) Copyright Avail: CASI HC A09/MF A03; 17 functional color pages

The results of this thesis demonstrate that direct numerical simulation can predict sound generation in unsteady aerodynamic flows containing shock waves. Shock waves can be significant sources of sound in high speed jet flows, on helicopter blades, and in supersonic combustion inlets. Direct computation of sound permits the prediction of noise levels in the preliminary design stage and can be used as a tool to focus experimental studies, thereby reducing cost and increasing the probability of a successfully quiet product in less time. This thesis reveals and investigates two

mechanisms fundamental to sound generation by shocked flows: shock motion and shock deformation. Shock motion is modeled by the interaction of a sound wave with a shock. During the interaction, the shock wave begins to move and the sound pressure is amplified as the wave passes through the shock. The numerical approach presented in this thesis is validated by the comparison of results obtained in a quasi-one dimensional simulation with linear theory. Analysis of the perturbation energy demonstrated for the first time that acoustic energy is generated by the interaction. Shock deformation is investigated by the numerical simulation of a ring vortex interacting with a shock. This interaction models the passage of turbulent structures through the shock wave. The simulation demonstrates that both acoustic waves and contact surfaces are generated downstream during the interaction. Analysis demonstrates that the acoustic wave spreads cylindrically, that the sound intensity is highly directional, and that the sound pressure level increases significantly with increasing shock strength. The effect of shock strength on sound pressure level is consistent with experimental observations of shock noise, indicating that the interaction of a ring vortex with a shock wave correctly models a dominant mechanism of shock noise generation. Author (revised)

N95-27990* Bionetics Corp., Hampton, VA.

MEASUREMENT AND PREDICTION OF BROADBAND NOISE FROM LARGE HORIZONTAL AXIS WIND TURBINE GENERATORS

F. W. GROSVELD, K. P. SHEPHERD, and H. H. HUBBARD (College of William and Mary, Williamsburg, VA.) In DASCON Engineering, Collected Papers on Wind Turbine Technology p 211-220 May 1995

Avail: CASI HC A02/MF A03

A method is presented for predicting the broadband noise spectra of large wind turbine generators. It includes contributions from such noise sources as the inflow turbulence to the rotor, the interactions between the turbulent boundary layers on the blade surfaces with their trailing edges and the wake due to a blunt trailing edge. The method is partly empirical and is based on acoustic measurements of large wind turbines and airfoil models. Spectra are predicted for several large machines including the proposed MOD-5B. Measured data are presented for the MOD-2, the WTS-4, the MOD-OA, and the U.S. Windpower Inc. machines. Good agreement is shown between the predicted and measured far field noise spectra. Author

N95-27991* Midwest Research Inst., Golden, CO.

OBSERVED ACOUSTIC AND AEROELASTIC SPECTRAL RESPONSES OF A MOD-2 TURBINE BLADE TO TURBULENCE EXCITATION

N. D. KELLEY, H. E. MCKENNA, and E. W. JACOBS In DASCON Engineering, Collected Papers on Wind Turbine Technology p 221-227 May 1995

(Contract(s)/Grant(s): DE-AC02-83CH-10093; EG-77-C-01-4042)

Avail: CASI HC A02/MF A03

Early results from a recent experiment designed to directly evaluate the aeroacoustic/elastic spectral responses of a MOD-2 turbine blade to turbulence-induced unsteady blade loads are discussed. The experimental procedure consisted of flying a hot-film anemometer from a tethered balloon in the turbine inflow and simultaneously measuring the fluctuating airload and aeroelastic response at two blade span stations (65% and 87% spans) using surface-mounted, subminiature pressure transducers and standard strain gage instrumentation. The radiated acoustic pressure field was measured with a triad of very-low-frequency microphones placed at ground level, 1.5 rotor diameters upwind of the disk. Initial transfer function estimates for acoustic radiation, blade normal forces, flapwise acceleration/displacement, and chord/flapwise moments are presented. Author

N95-27992* Massachusetts Inst. of Tech., Cambridge, MA.

ANEOCHOIC WIND TUNNEL STUDY OF TURBULENCE EFFECTS ON WIND TURBINE BROADBAND NOISE

B. LOYD and W. L. HARRIS In DASCON Engineering, Collected

Papers on Wind Turbine Technology p 229-236 May 1995
Presented at the DOE/NASA Workshop on Horizontal Axis Wind
Turbine Technology, Cleveland, OH, 8-10 May 1984
(Contract(s)/Grant(s): NAG3-378)
Avail: CASI HC A02/MF A03

This paper describes recent results obtained at MIT on the experimental and theoretical modelling of aerodynamic broadband noise generated by a downwind rotor horizontal axis wind turbine. The aerodynamic broadband noise generated by the wind turbine rotor is attributed to the interaction of ingested turbulence with the rotor blades. The turbulence was generated in the MIT anechoic wind tunnel facility with the aid of biplanar grids of various sizes. The spectra and the intensity of the aerodynamic broadband noise have been studied as a function of parameters which characterize the turbulence and of wind turbine performance parameters. Specifically, the longitudinal integral scale of turbulence, the size scale of turbulence, the number of turbine blades, and free stream velocity were varied. Simultaneous measurements of acoustic and turbulence signals were made. The sound pressure level was found to vary directly with the integral scale of the ingested turbulence but not with its intensity level. A theoretical model based on unsteady aerodynamics is proposed. Author

N95-28073*# Douglas Aircraft Co., Inc., Long Beach, CA.
AIRCRAFT IR/ACOUSTIC DETECTION EVALUATION.
VOLUME 2: DEVELOPMENT OF A GROUND-BASED
ACOUSTIC SENSOR SYSTEM FOR THE DETECTION OF
SUBSONIC JET-POWERED AIRCRAFT
ROBERT E. KRAFT (General Electric Co., Cincinnati, OH.) Dec.
1992 85 p
(Contract(s)/Grant(s): NAS1-19060; RTOP 505-63-70-02)
(NASA-CR-189705-VOL-2; NAS 1.26:189705-VOL-2) Avail: CASI
HC A05/MF A01

The design and performance of a ground-based acoustic sensor system for the detection of subsonic jet-powered aircraft is described and specified. The acoustic detection system performance criteria will subsequently be used to determine target detection ranges for the subject contract. Although the defined system has never been built and demonstrated in the field, the design parameters were chosen on the basis of achievable technology and overall system practicality. Areas where additional information is needed to substantiate the design are identified. Author

N95-28108# Lawrence Livermore National Lab., Livermore, CA.
WHIRL PLUS TILT
T. K. FOWLER 12 Oct. 1994 14 p
(Contract(s)/Grant(s): W-7405-ENG-48)
(DE95-007948; UCRL-ID-118981) Avail: CASI HC A03/MF A01

It is shown that, for an idealized rotor with identical magnetic bearings of negligible mass, precession and rotation are decoupled from the center-of-mass motion so that stabilization of whirl instabilities can be designed independent of tilt. The bearing torques that cause whirl also apply torques on the free-body-rotational motion in a tilted state. The rotational equations of motion including these torques are given in the paper. An approximate solution for a special case suggests the possibility of tilt instability above a critical frequency. DOE

N95-28264*# United Technologies Research Center, East Hartford, CT.
EVALUATION OF A DOUBLY-SWEPT BLADE TIP FOR
ROTORCRAFT NOISE REDUCTION Report, 20 Nov. 1990 -
15 Oct. 1992
BRIAN E. WAKE and T. ALAN EGOLF Oct. 1992 65 p
(Contract(s)/Grant(s): NAS1-19143)
(NASA-CR-189677; NAS 1.26:189677) Avail: CASI HC A04/MF
A01

A computational study was performed for a doubly-swept rotor blade tip to determine its benefit for high-speed impulsive (HSI) and blade-vortex interaction (BVI) noise. This design consists of aft and forward sweep. For the HSI-noise computations, unsteady Euler

calculations were performed for several variations to a rotor blade geometry. A doubly-swept planform was predicted to increase the delocalizing Mach number to 0.94 (representative of a 200+ kt helicopter). For the BVI-noise problem, it had been hypothesized that the doubly-swept blade tip, by producing a leading-edge vortex, would reduce the tip-vortex effect on BVI noise. A procedure was used in which the tip vortex velocity profile computed by a Navier-Stokes solver was used to compute the inflow associated with BVI. This inflow was used by a Euler solver to compute the unsteady pressures for an acoustic analysis. The results of this study were inconclusive due to the difficulty in accurately predicting the viscous tip vortex downstream of the blade. Also, for the condition studied, no leading-edge vortex formed at the tip. Author

N95-28670*# Boeing Commercial Airplane Co., Seattle, WA.
NOISE EXPOSURE REDUCTION OF ADVANCED HIGH-LIFT
SYSTEMS
STEPHEN W. HAFFNER May 1995 22 p
(Contract(s)/Grant(s): NAS1-20090; RTOP 538-03-15-01)
(NASA-CR-195077; NAS 1.26:195077) Avail: CASI HC A03/MF
A01

The purpose of NASA Contract NAS1-20090 Task 3 was to investigate the potential for noise reduction that would result from improving the high-lift performance of conventional subsonic transports. The study showed that an increase in lift-to-drag ratio of 15 percent would reduce certification noise levels by about 2 EPNdB on approach, 1.5 EPNdB on cutback, and zero EPNdB on sideline. In most cases, noise contour areas would be reduced by 10 to 20 percent. Author

17

SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A95-82665
INTERNATIONAL COOPERATION IN STANDARDIZATION
YOUSSEF EL GAMMAL CNES, Paris, France /In International
Symposium on Space Technology and Science, 18th, Kagoshima,
Japan, May 17-22, 1992. Vols. 1 & 2. A95-82299 Tokyo, Japan
ISTS Editorial Board 1992 p. 2437-2446
Copyright

General considerations, objectives and new areas of standardization, recent efforts within international standards organization technical committee 20 (ISO TC 20) in the space field, and the pros inherent to international cooperation in standardization are discussed. Author (Hemer)

A95-83158
THE LEGAL STATUS AND LIABILITY OF THE COPILOT,
PART 2
RUSSELL KANE and TONY PYNE Air & Space Law (ISSN 0927-
3379) vol. 20, no. 1 February 1995 p. 2-17
(HTN-95-A0578) Copyright

The definition of 'airmanship' is briefly discussed as it relates to aircraft pilots and copilots. The meaning's bearing on copilot liability is then considered, and examples are given where the copilot was found liable for a particular accident. Specific topics covered include the following: criminal liability, the licensing authority and the employer, accident investigations, the copilot's dilemma, and defenses available to the copilot. Hemer

N95-27209 National Inst. of Standards and Technology,
Gaithersburg, MD.
STEP: A FUTUREVISION, TODAY (Videotape)
1994 Videotape: 9 min. 50 sec. playing time, in color, with sound

(NONP-NASA-VT-95-49121) Avail: CASI VHS A02/BETA A22

STEP (STandard for the Exchange of Product Model Data) is an innovative software tool that allows the exchange of data between different programming systems to occur and helps speed up the designing in various process industries. This exchange occurs easily between those companies that have STEP, and many industries and government agencies are requiring that their vendors utilize STEP in their computer aided design projects, such as in the areas of mechanical, aeronautical, and electrical engineering. STEP allows the process of concurrent engineering to occur and increases the quality of the design product. One example of the STEP program is the Boeing 777, the first paperless airplane.

CASI

N95-28465* Analytical Services and Materials, Inc., Hampton, VA.

COINS: A COMPOSITES INFORMATION DATABASE SYSTEM

SHAHID SIDDIQI, LOUIS F. VOSTEEN, RALPH EDLOW, and TECK-SENG KWA. In FAA, Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Volume 2 p 621-629 Sep. 1992. Previously announced as X92-10407

Avail: CASI HC A02/MF A04

An automated data abstraction form (ADAF) was developed to collect information on advanced fabrication processes and their related costs. The information will be collected for all components being fabricated as part of the ACT program and include in a COmposites INformation System (COINS) database. The aim of the COINS development effort is to provide future airframe preliminary design and fabrication teams with a tool through which production cost can become a deterministic variable in the design optimization process. The effort was initiated by the Structures Technology Program Office (STPO) of the NASA LaRC to implement the recommendations of a working group comprised of representatives from the commercial airframe companies. The principal working group recommendation was to re-institute collection of composite part fabrication data in a format similar to the DOD/NASA Structural Composites Fabrication Guide. The fabrication information collection form was automated with current user friendly computer technology. This work in progress paper describes the new automated form and features that make the form easy to use by an aircraft structural design-manufacturing team.

Author

18

SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

A95-86113

MOBILE DOMES FOR TACTIC TELESCOPE

B. N. KARKERA Bhabha Atomic Research Centre, Bombay, India, I. K. PURI Bhabha Atomic Research Centre, Bombay, India, C. L. BHAT Bhabha Atomic Research Centre, Bombay, India, R. KOUL Bhabha Atomic Research Centre, Bombay, India, G. S. K. MURTHY Bhabha Atomic Research Centre, Bombay, India, R. L. SUTHAR Bhabha Atomic Research Centre, Bombay, India, and S. H. KAMBLE Bhabha Atomic Research Centre, Bombay, India Astronomical Society of India Meeting, 15th, Bombay, India, March 2-5, 1993. A95-86050 Astronomical Society of India, Bulletin (ISSN 0304-9523) vol. 21, no. 3-4 September-December 1993 p. 523-526 Copyright

A system of mobile domes which have a minimal shadowing effect, is proposed for the TACTIC telescope being set up at Gurushikar, Mt. Abu. The important design considerations and the salient features of the proposed concept are discussed.

Author (Hemer)

N95-26427* National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

RADIATION SAFETY ASPECTS OF COMMERCIAL HIGH-SPEED FLIGHT TRANSPORTATION

JOHN W. WILSON, JOHN E. NEALY, FRANCIS A. CUCINOTTA, JUDY L. SHINN, FERENC HAJNAL (Department of Energy, New York, NY.), MARCEL REGINATTO (Department of Energy, New York, NY.), and PAUL GOLDHAGEN (Department of Energy, New York, NY.) May 1995 33 p

(Contract(s)/Grant(s): RTOP 537-09-21-05)

(NASA-TP-3524; L-17450; NAS 1.60:3524) Avail: CASI HC A03/MF A01

High-speed commercial flight transportation is being studied for intercontinental operations in the 21st century, the projected operational characteristics for these aircraft are examined, the radiation environment as it is now known is presented, and the relevant health issues are discussed. Based on a critical examination of the data, a number of specific issues need to be addressed to ensure an adequate knowledge of the ionizing radiation health risks of these aircraft operations. Large uncertainties in our knowledge of the physical fields for high-energy neutrons and multiply-charged ion components need to be reduced. Improved methods for estimating risks in prenatal exposure need to be developed. A firm basis for solar flare monitoring and forecasting needs to be developed with means of exposure abatement.

Author

19

GENERAL

N95-27367* National Aeronautics and Space Administration, Ames Research Center, Moffett Field, CA.

NAS TECHNICAL SUMMARIES, MARCH 1993 - FEBRUARY 1994

Jan. 1995 136 p

(Contract(s)/Grant(s): RTOP 536-01-11)

(NASA-RP-1355; A-94140; NAS 1.61:1355) Avail: CASI HC A07/MF A02

NASA created the Numerical Aerodynamic Simulation (NAS) Program in 1987 to focus resources on solving critical problems in aerospace and related disciplines by utilizing the power of the most advanced supercomputers available. The NAS Program provides scientists with the necessary computing power to solve today's most demanding computational fluid dynamics problems and serves as a pathfinder in integrating leading-edge supercomputing technologies, thus benefitting other supercomputer centers in government and industry. The 1993-94 operational year concluded with 448 high-speed processor projects and 95 parallel projects representing NASA, the Department of Defense, other government agencies, private industry, and universities. This document provides a glimpse at some of the significant scientific results for the year.

Author

N95-28002* National Aeronautics and Space Administration, Washington, DC.

RESEARCH AND TECHNOLOGY OBJECTIVES AND PLANS SUMMARY (RTOPS)

Research and Technology Program, FY 1993 Mar. 1993 202 p

(NASA-TM-108574; NAS 1.15:108574) Avail: CASI HC A10/MF A03

This publication represents the NASA research and technology program for FY-93. It is a compilation of the Summary portions of each of the RTOP's (Research and Technology Objectives and Plans) used for management review and control of research currently in progress throughout NASA. The RTOP Summary is designed to facilitate communication and coordination among concerned technical personnel in government, in industry, and in universities.

19 GENERAL

The first section containing citations and abstracts of the RTOP's is followed by four indexes: Subject, Technical Monitor, Responsible NASA Organization, and RTOP Number. Author

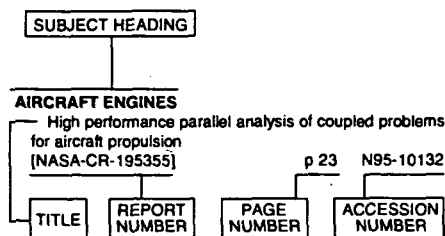
N95-28038*# Loyola Coll., Baltimore, MD. International Technology Research Inst.

**JTEC/WTEC ANNUAL REPORT AND PROGRAM SUMMARY:
1993/94**

GEOFFREY M. HOLDRIDGE, ed. Mar. 1994 204 p
(Contract(s)/Grant(s): NSF ECS-89-02528; NSF ECS-89-22947;
NSF ENG-91-11333; NSF ENG-92-17849)
(NASA-CR-198563; NAS 1.26:198563; ISBN-1-883-71231-9; PB94-
155702) Avail: CASI HC A10/MF A03

The JTEC/WTEC (Japanese Technology Evaluation Center/
World Technology Evaluation Center) Program at Loyola College is
overviewed. A review of activities for 1993 and early 1994 is
discussed along with plans for the following year. The bulk of the
report consists of the summaries of completed projects in Information
and Communication Technology; Materials; Manufacturing and
Construction; Aeronautics, Space, and Ocean Technology; Energy;
and Biotechnology. CASI

Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of document content, a title extension is added, separated from the title by three hyphens. The accession number and the page number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document. Under any one subject heading, the accession numbers are arranged in sequence.

A

ACCELERATION TOLERANCE

Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993
[SAE SP-992] p 417 A95-84553

The large radius track centrifuge concept as an acceleration research and simulation device
p 379 A95-84560

ACCELEROMETERS

Bearing defect signature analysis using advanced nonlinear signal analysis in a controlled environment
[NASA-TM-108491] p 441 N95-28364

ACCIDENT PREVENTION

Prevention and control of inlet unstart using an SR-71 simulation
p 367 N95-26948

ACCUMULATORS

Replicator for characterization of cirrus and polar stratospheric cloud particles
[NASA-CR-197785] p 445 N95-26669

ACCE PROGRAM

NASA-ACCE/Boeing 737 graphite-epoxy horizontal stabilizer service
p 400 N95-28489

ACOUSTIC ATTENUATION

Suppressor of oscillations in airframe cavities
[AD-D017265] p 388 N95-26507

ACOUSTIC COUPLING

Interaction of jet noise with a nearby panel assembly
[BTN-95-EIX95262694295] p 434 A95-85466

ACOUSTIC EMISSION

Bearing defect signature analysis using advanced nonlinear signal analysis in a controlled environment
[NASA-TM-108491] p 441 N95-28364

ACOUSTIC EXCITATION

Transonic flutter suppression using active acoustic excitations
[BTN-95-EIX95262694310] p 408 A95-85481

Near field of a coaxial jet with and without axial excitation

[HTN-95-42332] p 372 A95-86161

Active open-loop control of particle dispersion in round jets

[HTN-95-42334] p 372 A95-86163

High angle-of-attack airfoil performance improvement by internal acoustic excitation

[HTN-95-42347] p 372 A95-86176

ACOUSTIC PROPAGATION

Nonreflective boundary conditions for high-order methods

[HTN-95-42328] p 371 A95-86157

ACOUSTIC PROPERTIES

Photoacoustic chambers for studying solids and gases: Theory and practical examples

[IFTR-39/1994] p 412 N95-26837

The noise reduction potential of dual-stream coaxial rectangular improperly expanded jet flows

[NASA-CR-197820] p 437 N95-26995

Anechoic wind tunnel study of turbulence effects on wind turbine broadband noise

p 451 N95-27992

Evaluation of a doubly-swept blade tip for rotorcraft noise reduction

[NASA-CR-189677] p 452 N95-28264

ACOUSTICS

Acoustic field in unsteady moving media

[NASA-CR-198162] p 438 N95-27179

ACTIVE CONTROL

Transonic flutter suppression using active acoustic excitations

[BTN-95-EIX95262694310] p 408 A95-85481

Active open-loop control of particle dispersion in round jets

[HTN-95-42334] p 372 A95-86163

ACTUATORS

Torsional actuation with extension-torsion composite coupling and a magnetostrictive actuator

[BTN-95-EIX95262694314] p 435 A95-85485

Design and development of a test rig for the high frequency testing of rolling sleeve airsprings

[DSTO-TN-0001] p 411 N95-26378

Electro-hydrostatic actuator controller design using quantitative feedback theory

[AD-A289220] p 409 N95-26957

Composite flight-control actuator development

p 410 N95-28281

ADA (PROGRAMMING LANGUAGE)

EASY-SIM: A visual simulation system software architecture with an Ada 9X application framework

[AD-A289325] p 448 N95-26895

ADAPTIVE CONTROL

Neuro-controllers for adaptive helicopter training

[SAE PAPER 932535] p 379 A95-84557

A gain scheduling optimization method using genetic algorithms

[AD-A289306] p 448 N95-26920

ADDITIVES

The effect of aviation fuels containing low amounts of static dissipater additive on electrostatic charge generation

[AD-A280075] p 420 N95-28152

ADHESIVE BONDING

Adhesively bonded composite patch repair of cracked aluminum alloy structures

p 393 N95-27507

Field repair materials for naval aircraft

p 394 N95-27514

The development of an engineering standard for composite repairs

p 396 N95-27528

Recent developments in nylon superpressure balloons

p 385 A95-82512

Field repair materials for naval aircraft

p 394 N95-27514

Repair of high temperature composite aircraft structure

p 395 N95-27520

ADJUSTING

Aircraft fuel system lightning protection design and qualification test procedures development

[AD-A288401] p 380 N95-26497

ADVECTION

A numerical model to predict the fate of jettisoned aviation fuel

[AD-A289336] p 419 N95-26842

AERIAL RECONNAISSANCE

Geophex airborne unmanned survey system

[DE95-007566] p 392 N95-27440

AEROACOUSTICS

Structure of supersonic jet flow and its radiated sound

[HTN-95-51645] p 431 A95-85027

Screech tones from free and ducted supersonic jets

[HTN-95-51647] p 432 A95-85029

Aircraft noise prediction program theoretical manual: Rotorcraft System Noise Prediction System (ROTONET), part 4

[NASA-TM-83199-PT-4] p 451 N95-26392

Turbomachinery design and tonal acoustics computations

[NASA-CR-197749] p 406 N95-26777

Supersonic coaxial jet noise predictions

[NASA-TM-106917] p 451 N95-26801

A numerical study of fundamental shock noise mechanisms

[NASA-TM-110608] p 451 N95-27908

Anechoic wind tunnel study of turbulence effects on wind turbine broadband noise

p 451 N95-27992

Evaluation of a doubly-swept blade tip for rotorcraft noise reduction

[NASA-CR-189677] p 452 N95-28264

Noise exposure reduction of advanced high-lift systems

[NASA-CR-195077] p 452 N95-28670

Response of multi-panel assembly to noise from a jet in forward motion

[NASA-CR-198164] p 442 N95-28673

AEROBRAKING

How 'HITEN's' aerobraking experiments were carried out

p 415 A95-82553

Aero-thermodynamic flight environment at HITEN aerobrake experiment

p 415 A95-82554

The effect of high lift to drag ratio on aerobraking

p 415 A95-85807

Rarefied gas effects on aerobraking/reentry vehicles with wakes

[NASA-CR-196586] p 415 N95-27093

AEROCAPTURE

The effect of high lift to drag ratio on aerobraking

p 415 A95-85807

AERODYNAMIC BALANCE

Air resonance of hingeless rotor helicopters in trimmed forward flight

[HTN-95-61075] p 369 A95-83659

An easy way to analyze longitudinal and lateral-directional trim problems with AEO or OEI

p 409 N95-26949

AERODYNAMIC BRAKES

Comparative wind tunnel tests of NACA 23024 airfoils with several aileron and spoiler configurations

p 376 N95-27976

AERODYNAMIC CHARACTERISTICS

The aerodynamic characteristics of cup-like body in supersonic flow

p 427 A95-82407

NAL aerothermodynamic probing and CFD verification mission in OREX experiment

p 368 A95-82413

A concept of a hypersonic flight experiment of a winged vehicle

p 414 A95-82477

T-45A high angle attack testing

[HTN-95-81499] p 386 A95-85213

Simulation model of the integrated flight/propulsion control system, displays, and propulsion system for ASTOVL lift-fan aircraft

[NASA-TM-108866] p 405 N95-26412

Suppressor of oscillations in airframe cavities

[AD-D017265] p 388 N95-26507

Development and validation of a blade-element mathematical model for the AH-64A Apache helicopter

[NASA-TM-108863] p 367 N95-26710

AIAA Techfest 20 Proceedings

[NIAR-94-1] p 367 N95-26941

Modeling of aircraft unsteady aerodynamic characteristics. Part 2: Parameters estimated from wind tunnel data
[NASA-TM-110161] p 410 N95-27839
Comparative wind tunnel test at high Reynolds numbers of NACA 64 621 airfoils with two airfoil configurations p 377 N95-27977

AERODYNAMIC COEFFICIENTS

Wind-tunnel tests of an inclined cylinder having helical grooves
[BTN-95-EIX95262694306] p 411 A95-85477
User documentation of the CTA program
[AD-A289508] p 375 N95-26854
Wind-tunnel test of the S814 thick root airfoil
[DE95-000268] p 376 N95-27541

AERODYNAMIC CONFIGURATIONS

Aeroelasticity of wing and wing-body configurations on parallel computers
[NASA-CR-197756] p 389 N95-26590
Design and testing of low sonic boom configurations and an oblique all-wing supersonic transport
[NASA-CR-197744] p 389 N95-26651
Supersonic civil airplane study and design: Performance and sonic boom
[NASA-CR-197745] p 390 N95-26813
An exploratory application of neural networks for airfoil design
[NASA-CR-197820] p 448 N95-26943
The noise reduction potential of dual-stream coaxial rectangular improperly expanded jet flows
[NASA-CR-197820] p 437 N95-26995
The lift-fan aircraft: Lessons learned
[NASA-CR-196694] p 392 N95-27143
NAS Technical Summaries, March 1993 - February 1994
[NASA-RP-1355] p 453 N95-27367

AERODYNAMIC DRAG

Flow past a symmetric wedge with forward splitter plate
[NASA-CR-197820] p 427 A95-82406
Numerical investigation of cylinder wake flow with a rear stagnation jet
[HTN-95-51669] p 433 A95-85051
Effect of Reynolds number and turbulence on airfoil aerodynamics at -90-degree incidence
[HTN-95-42320] p 370 A95-86149
Comparative wind tunnel test at high Reynolds numbers of NACA 64 621 airfoils with two airfoil configurations p 377 N95-27977
A hybrid vehicle evaluation code and its application to vehicle design. Revision 1
[DE95-008053] p 441 N95-28029
A hybrid vehicle evaluation code and its application to vehicle design, revision 2
[DE95-008060] p 441 N95-28139
Construction and wind tunnel test of a 1/12th scale helicopter model
[AD-A288487] p 378 N95-28331
Study of potential aerodynamic benefits from spanwise blowing at wingtip
[NASA-TP-3515] p 378 N95-28669

AERODYNAMIC FORCES

Aero-thermodynamic flight environment at HITEN aerobrace experiment p 415 A95-82554
Force and moment on a Joukowski profile in the presence of point vortices
[BTN-95-EIX95262694298] p 434 A95-85469
Wind-tunnel tests of an inclined cylinder having helical grooves
[BTN-95-EIX95262694306] p 411 A95-85477

AERODYNAMIC HEATING

Research and development of thermal protection system of HOPE re-entry vehicle p 413 A95-82358
VSL analysis of hypersonic flows around a reentry vehicle with equilibrium air chemistry p 413 A95-82400
Hypersonic thermal protection with mass injection at angle of attack p 414 A95-82414
Numerical simulation of unsteady aerodynamic heating induced by shock reflections p 428 A95-82418
A study on aerodynamic heating phenomena in three-dimensional shock wave/turbulent boundary layer interaction induced by sweptback sharp fins at supersonic flow p 428 A95-82419
Reentry technology experiment on the first mission of reentry capsule 'EXPRESS' p 414 A95-82499
Aero-thermodynamic flight environment at HITEN aerobrace experiment p 415 A95-82554
Studies on gain performance of a combustion driven CO2 gas dynamic laser p 428 A95-82679
The effects of wall perturbations on thermo-turbulent Couette flow p 434 A95-85299
Reentry analysis for low Earth orbiting spacecraft p 415 A95-85774
Viscous shock-layer analysis on hypersonic flow over reentry capsule with nonequilibrium chemistry [ISAS-656] p 436 N95-26739

Rarefied gas effects on aerobraking/reentry vehicles with wakes
[NASA-CR-196586] p 415 N95-27093

AERODYNAMIC LOADS

Effects of blade tip shape on dynamics, cost, weight, aerodynamic performance, and aeroelastic response
[HTN-95-61074] p 369 A95-83658
Stability of viscoelastic plate in supersonic flow under random loading
[BTN-95-EIX95262694312] p 435 A95-85483
Stress considerations in reduced-size aeroelastic optimization
[BTN-95-EIX95262694313] p 366 A95-85484
Equivalent beam-column analysis of guyed towers
[BTN-95-EIX95262696644] p 435 A95-85519
F/A-18 IFOSTP Fatigue test airbag load determination on the vertical and horizontal tails
[DSTO-TR-0135] p 388 N95-26389
Computational analysis of forebody tangential slot blowing on the high alpha research vehicle
[NASA-CR-197754] p 389 N95-26591
Preliminary analysis of dynamic stall effects on a 91-meter wind turbine rotor p 376 N95-27975
Observed acoustic and aeroelastic spectral responses of a MOD-2 turbine blade to turbulence excitation p 451 N95-27991
Aeroelasticity and structural optimization of composite helicopter rotor blades with swept tips
[NASA-CR-4665] p 397 N95-28262
AERODYNAMIC NOISE
Interaction of jet noise with a nearby panel assembly
[BTN-95-EIX95262694295] p 434 A95-85466
Aircraft noise prediction program theoretical manual: Rotorcraft System Noise Prediction System (ROTONET), part 4
[NASA-TM-83199-PT-4] p 451 N95-26392
A numerical study of fundamental shock noise mechanisms
[NASA-TM-110608] p 451 N95-27908
Anechoic wind tunnel study of turbulence effects on wind turbine broadband noise p 451 N95-27992
Noise exposure reduction of advanced high-lift systems
[NASA-CR-195077] p 452 N95-28670
Response of multi-panel assembly to noise from a jet in forward motion
[NASA-CR-198164] p 442 N95-28673
AERODYNAMIC STABILITY
Air resonance of hingeless rotor helicopters in trimmed forward flight
[HTN-95-61075] p 369 A95-83659
An analytical model for a nonlinear elastomeric lag damper and its effect on aeromechanical stability in Hover
[HTN-95-61076] p 369 A95-83660
AIAA Techfest 20 Proceedings
[NIAR-94-1] p 367 N95-26941

AERODYNAMIC STALLING

Reattachment studies of an oscillating airfoil dynamic stall flowfield
[HTN-95-51660] p 432 A95-85042
Predicting stall and post-stall behavior of airfoils at low mach numbers
[BTN-95-EIX95262694297] p 365 A95-85468
Interferometric investigations of compressible dynamic stall over a transiently pitching airfoil
[HTN-95-42338] p 372 A95-86167
High angle-of-attack airfoil performance improvement by internal acoustic excitation
[HTN-95-42347] p 372 A95-86176
Stall precursor study of high frequency data for three high speed, swept compressor rotors
[AD-A289379] p 406 N95-26878
Horizontal axis wind turbine post stall airfoil characteristics synthesisization p 376 N95-27974
Preliminary analysis of dynamic stall effects on a 91-meter wind turbine rotor p 376 N95-27975

AERODYNAMICS

Polar Patrol Balloon system and preliminary experimental results p 368 A95-82513
Matrix fraction approach for finite-state aerodynamic modeling
[BTN-95-EIX95262694311] p 365 A95-85482
Effect of Reynolds number and turbulence on airfoil aerodynamics at -90-degree incidence
[HTN-95-42320] p 370 A95-86149
Suppressor of oscillations in airframe cavities
[AD-DO17265] p 388 N95-26507
Wind-tunnel test of the S814 thick root airfoil
[DE95-000268] p 376 N95-27541
Aeronautical engineering: A continuing bibliography with indexes (supplement 318)
[NASA-SP-7037(318)] p 367 N95-27543
Study of potential aerodynamic benefits from spanwise blowing at wingtip
[NASA-TP-3515] p 378 N95-28669

AEROELASTIC RESEARCH WINGS

Structural design optimization with survivability dependent constraints application: Primary wing box of a multi-role fighter p 398 N95-28440

AEROELASTICITY

Effects of blade tip shape on dynamics, cost, weight, aerodynamic performance, and aeroelastic response
[HTN-95-61074] p 369 A95-83658
Stress considerations in reduced-size aeroelastic optimization
[BTN-95-EIX95262694313] p 366 A95-85484
Aeroelastic stability of cascades in turbomachinery
[HTN-95-61156] p 405 A95-86255
A non-iterative grid deformation algorithm for computational fluid dynamics for aeroelasticity
[AD-A288298] p 436 N95-26418
Aeroelasticity of wing and wing-body configurations on parallel computers
[NASA-CR-197756] p 389 N95-26590
Aeroelastic stability of wind turbine blade/aileron systems p 377 N95-27981
Observed acoustic and aeroelastic spectral responses of a MOD-2 turbine blade to turbulence excitation p 451 N95-27991
Aeroelasticity and structural optimization of composite helicopter rotor blades with swept tips
[NASA-CR-4665] p 397 N95-28262
Unique considerations in the design and experimental evaluation of tailored wings with elastically produced chordwise camber p 423 N95-28436
Nonlinear dynamics and aeroelasticity of rotorcraft in forward flight
[AD-A291714] p 400 N95-28504

AERONAUTICAL ENGINEERING

Asian Aeronautics: Technology acquisition drives industry development. Report to Congressional requesters
[GAO/NSIAD-94-140] p 367 N95-26817
The noise reduction potential of dual-stream coaxial rectangular improperly expanded jet flows
[NASA-CR-197820] p 437 N95-26995
Aeronautical engineering: A continuing bibliography with indexes (supplement 318)
[NASA-SP-7037(318)] p 367 N95-27543
A review of Australian and New Zealand investigations on aeronautical fatigue during the period Apr. 1993 - Mar. 1995
[AR-009-202] p 397 N95-27918
JTEC/WTEC annual report and program summary: 1993/94
[NASA-CR-198563] p 454 N95-28038

AERONAUTICS

Research and Technology Objectives and Plans Summary (RTOPS)
[NASA-TM-108574] p 453 N95-28002

AEROSOLS

Effects of a polar stratosphere cloud parameterization on ozone depletion due to stratospheric aircraft in a two-dimensional model
[HTN-95-A1038] p 443 A95-84543
Two dimensional stratospheric aerosol distributions during EASOE
[HTN-95-00726] p 444 A95-86296
Airborne measurements during the Arctic stratospheric experiment: Observation of O3 and NO2
[HTN-95-00748] p 445 A95-86318
Transport phenomena and interfacial kinetics in multiphase combustion systems
[AD-A288297] p 418 N95-26417

AEROSPACE ENGINEERING

High-stakes aviation: US-Japan technology linkages in transport aircraft
[LC-94-65759] p 381 N95-27907
Research and Technology Objectives and Plans Summary (RTOPS)
[NASA-TM-108574] p 453 N95-28002
Probabilistic design of advanced composite structure p 424 N95-28443
Probabilistic evaluation of fuselage-type composite structures p 398 N95-28444

AEROSPACE INDUSTRY

International cooperation in standardization p 452 A95-82665
Asian Aeronautics: Technology acquisition drives industry development. Report to Congressional requesters
[GAO/NSIAD-94-140] p 367 N95-26817
High-stakes aviation: US-Japan technology linkages in transport aircraft
[LC-94-65759] p 381 N95-27907
AEROSPACE PLANES
An advanced scramjet propulsion concept for A 350 MG SSTO space plane p 402 A95-82325
Test results on air turbo ramjet engine for a future space plane p 402 A95-82327
R & D on HOPE structure p 413 A95-82355

- Research and development of thermal protection system of HOPE re-entry vehicle p 413 A95-82358
- Hypersonic trajectory control of aerospace plane with integrated SCRAMJET engine p 413 A95-82384
- Air data sensors for atmospheric reentry flight test of winged space vehicle p 413 A95-82412
- Hypersonic thermal protection with mass injection at angle of attack p 414 A95-82414
- Experiment and analysis on heat transfer of a scramjet leading edge model p 403 A95-82420
- AEROSPACE SCIENCES**
- NAS Technical Summaries, March 1993 - February 1994
- [NASA-RP-1355] p 453 N95-27367
- Research and Technology Objectives and Plans Summary (RTOPS)
- [NASA-TM-108574] p 453 N95-28002
- AEROTHERMOCHEMISTRY**
- VSL analysis of hypersonic flows around a reentry vehicle with equilibrium air chemistry p 413 A95-82400
- NAL aerothermodynamic probing and CFD verification mission in OREX experiment p 368 A95-82413
- AEROTHERMODYNAMICS**
- NAL aerothermodynamic probing and CFD verification mission in OREX experiment p 368 A95-82413
- An experimental study on radiation from strong shock layer p 368 A95-82421
- A conceptual design of hypersonic research vehicle with subscale scramjet engine p 384 A95-82482
- Aero-thermodynamic flight environment at HITEN aerobrake experiment p 415 A95-82554
- Viscous shock-layer analysis on hypersonic flow over reentry capsule with nonequilibrium chemistry [ISAS-656] p 436 N95-26739
- AH-64 HELICOPTER**
- Development and validation of a blade-element mathematical model for the AH-64A Apache helicopter [NASA-TM-108863] p 367 N95-26710
- AILERONS**
- Full span flaperons for a biplane p 391 N95-26954
- Comparative wind tunnel test at high Reynolds numbers of NACA 64 621 airfoils with two aileron configurations p 377 N95-27977
- Aeroelastic stability of wind turbine blade/aileron systems p 377 N95-27981
- AIR**
- Ignition analysis of hydrogen/air mixture in supersonic mixing layer p 416 A95-82301
- Hypersonic thermal protection with mass injection at angle of attack p 414 A95-82414
- Stationary premixed flames in spherical and cylindrical geometries [HTN-95-42336] p 418 A95-86165
- Flowfield measurements in supersonic film cooling including the effect of shock-wave interaction [HTN-95-42337] p 405 A95-86166
- AIR BAG RESTRAINT DEVICES**
- F/A-18 IFOSTP Fatigue test airbag load determination on the vertical and horizontal tails [DSTO-TR-0135] p 388 N95-26389
- AIR CARGO**
- Incorporating biplane wing theory into a large, subsonic, all-cargo transport p 391 N95-26956
- Enplanement and all cargo activity [AD-A280074] p 412 N95-28151
- AIR FLOW**
- Pressure and temperature distortion testing of a two-stage centrifugal compressor [BTN-94-EIX95011441250] p 431 A95-84207
- Compressible Navier-Stokes computations of multielement airfoil flows using multiblock grids [HTN-95-42327] p 371 A95-86156
- Nonreflective boundary conditions for high-order methods [HTN-95-42328] p 371 A95-86157
- General solution procedure for flows in local chemical equilibrium [HTN-95-42329] p 404 A95-86158
- Flutter clearance flight tests of an OV-10A airplane modified for wake vortex flight experiments [NASA-TM-109168] p 366 N95-26381
- AIR JETS**
- Computational/experimental investigation of staged injection into a Mach 2 flow [HTN-95-51646] p 432 A95-85028
- Active open-loop control of particle dispersion in round jets [HTN-95-42334] p 372 A95-86163
- AIR LAND INTERACTIONS**
- Airborne lidar observation of mountain-wave-induced polar stratospheric clouds during EASOE [HTN-95-00738] p 444 A95-86308
- AIR NAVIGATION**
- Design and synthesis of a real-time controller for an unmanned air vehicle [AD-A289134] p 408 N95-26555
- AIR POLLUTION**
- An overview of the EASOE campaign [HTN-95-00702] p 443 A95-86272
- AIR SAMPLING**
- Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system p 440 N95-27983
- AIR TRAFFIC**
- Air traffic operational inventory CY 1994 [AD-A288281] p 382 N95-26454
- The 1994 updated National Airspace System performance assessment for year 2005 [AD-A288652] p 380 N95-26485
- Enplanement and all cargo activity [AD-A280074] p 412 N95-28151
- AIR TRAFFIC CONTROL**
- Weather And Radar Processor (WARP) Test and Evaluation Master Plan (TEMP) [AD-A288280] p 445 N95-26453
- Air traffic operational inventory CY 1994 [AD-A288281] p 382 N95-26454
- The 1994 updated National Airspace System performance assessment for year 2005 [AD-A288652] p 380 N95-26485
- The controller memory guide. Concepts from the field [AD-A289263] p 383 N95-26978
- Advanced interactive display formats for terminal area traffic control [NASA-CR-198576] p 384 N95-28188
- Development of a coding form for approach control/pilot voice communications [DOT/FAA/AM-95/15] p 384 N95-28540
- Proceedings of the AIAA/FAA joint symposium on general aviation systems [AD-A289830] p 368 N95-28610
- AIR TRAFFIC CONTROLLERS (PERSONNEL)**
- The controller memory guide. Concepts from the field [AD-A289263] p 383 N95-26978
- Development of a coding form for approach control/pilot voice communications [DOT/FAA/AM-95/15] p 384 N95-28540
- AIR TRANSPORTATION**
- The high speed civil transport and NASA's High Speed Research (HSR) program p 390 N95-26945
- Enplanement and all cargo activity [AD-A280074] p 412 N95-28151
- AIRBORNE EQUIPMENT**
- Data processing and mapping in airborne radiometric surveys [HTN-95-51587] p 442 A95-83591
- Mapping of forest fire damages using imaging spectroscopy p 442 A95-83627
- Hardware cleanliness methodology and certification p 419 N95-27656
- AIRBORNE/SPACEBORNE COMPUTERS**
- Air data sensors for atmospheric reentry flight test of winged space vehicle p 413 A95-82412
- Advanced flight computer. Special study [NASA-CR-198165] p 449 N95-27246
- AIRCRAFT**
- Fast Floquet theory and trim for multi-bladed rotorcraft [HTN-95-61078] p 370 A95-83662
- AIRCRAFT ACCIDENT INVESTIGATION**
- Aircraft accident report: Controlled collision with Terrain Transportes Aereos Ejecutivos, S.A. (TAESA) Learjet 25D, XA-BBA Dulles International Airport Chantilly, Virginia, June 18, 1994 [NTSB/AAR-95/02] p 380 N95-26498
- AIRCRAFT ACCIDENTS**
- The legal status and liability of the copilot, part 2 [HTN-95-00578] p 452 A95-83158
- Aircraft accident report: Controlled collision with Terrain Transportes Aereos Ejecutivos, S.A. (TAESA) Learjet 25D, XA-BBA Dulles International Airport Chantilly, Virginia, June 18, 1994 [NTSB/AAR-95/02] p 380 N95-26498
- Prevention and control of inlet unstart using an SR-71 simulation p 367 N95-26948
- AIRCRAFT ANTENNAS**
- Wind-tunnel tests of an inclined cylinder having helical grooves [BTN-95-EIX95262694306] p 411 A95-85477
- AIRCRAFT CARRIERS**
- Benefits and limitations of composites in carrier-based aircraft p 422 N95-28422
- AIRCRAFT COMMUNICATION**
- Development of a coding form for approach control/pilot voice communications [DOT/FAA/AM-95/15] p 384 N95-28540
- AIRCRAFT COMPARTMENTS**
- Human factors issues in aircraft cabin design [SAE PAPER 932527] p 386 A95-84556
- AIRCRAFT CONFIGURATIONS**
- Aeroelasticity of wing and wing-body configurations on parallel computers [NASA-CR-197756] p 389 N95-26590
- Comparison of fixed wing aircraft algorithms for JANUS [AD-A288503] p 389 N95-26652
- Supersonic civil airplane study and design: Performance and sonic boom [NASA-CR-197745] p 390 N95-26813
- A quantitative feedback theory FCS design for the subsonic envelope of the VISTA F-16 including configuration variation [AD-A289221] p 409 N95-26958
- Test operations procedure (TOP) 7-3-534 airworthiness testing of fixed wing aircraft: Asymmetric power testing [AD-A289458] p 391 N95-26994
- AIRCRAFT CONSTRUCTION MATERIALS**
- Flight simulation fatigue crack growth testing of aluminum alloys [HTN-95-00652] p 418 A95-84731
- Forming and bonding techniques for high-strength aluminum alloys [HTN-95-20605] p 418 A95-84786
- Fatigue of aircraft materials; Specialists' Conference, Delft, Netherlands, 1992 [HTN-95-B0076] p 387 A95-85892
- Fatigue of aircraft materials and structures p 387 A95-85894
- Fibre-Metal laminates p 387 A95-85895
- Applying nanostructured materials to future gas turbine engines [HTN-95-11909] p 404 A95-85990
- Static and fatigue testing of full-scale fuselage panels fabricated using a Therm-X(R) process p 420 N95-28270
- ACT/ICAPS: Thermoplastic composite activities p 421 N95-28274
- Development of composite carrythrough bulkhead p 423 N95-28438
- Effects of floor location on response of composite fuselage frames p 423 N95-28439
- Navy composite maintenance and repair experience p 424 N95-28446
- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 2 [NASA-CR-198722] p 424 N95-28462
- Overview of the ACT program p 424 N95-28463
- Characterization and manufacture of braided composites for large commercial aircraft structures p 426 N95-28478
- Impact damage resistance of composite fuselage structure, part 1 p 399 N95-28482
- Fundamental concepts in the suppression of delamination buckling by stitching p 426 N95-28486
- Advanced wing design survivability testing and results p 400 N95-28488
- AIRCRAFT CONTROL**
- Robust longitudinal axis flight control for an aircraft with thrust vectoring [BTN-95-EIX95122538875] p 408 A95-83000
- Nonlinear decoupling control study for aircraft maneuvering flight [HTN-95-71130] p 408 A95-83491
- T-45A high angle attack testing [HTN-95-81499] p 386 A95-85213
- Simulation model of the integrated flight/propulsion control system, displays, and propulsion system for ASTOVL lift-fan aircraft [NASA-TM-108866] p 405 N95-26412
- Development of a nonlinear simulation for the McDonnell Douglas F-15 Eagle with a longitudinal TECS control-law [AD-A288610] p 388 N95-26481
- A comparison of the Neal-Smith and omega Tau function, zeta function and tau function flying qualities criteria [AD-A289503] p 390 N95-26844
- AIRCRAFT DESIGN**
- An advanced scramjet propulsion concept for A 350 MG SSTO space plane p 402 A95-82325
- A conceptual design of hypersonic research vehicle with subscale scramjet engine p 384 A95-82482
- European firms team on supersonic studies [HTN-95-42215] p 386 A95-84031
- Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993 [SAE SP-992] p 417 A95-84553
- Charles Norvin Rinek; an early American pioneer in advanced aviation engines [SAE PAPER 930485] p 386 A95-84554
- Flying qualities development and flight simulation evaluation of the TW-68 tilt-wing VTOL aircraft [SAE PAPER 932517] p 386 A95-84555
- Human factors issues in aircraft cabin design [SAE PAPER 932527] p 386 A95-84556

- Fatigue of aircraft materials and structures p 387 A95-85894
- Fibre-Metal laminates p 387 A95-85895
- Elements of structural integrity assurance p 387 A95-85896
- Damage tolerance capability p 388 A95-85898
- Aircraft fuel system lightning protection design and qualification test procedures development [AD-A288401] p 380 N95-26497
- Balanced on air aircraft [AD-D017251] p 389 N95-26537
- Aeroelasticity of wing and wing-body configurations on parallel computers [NASA-CR-197756] p 389 N95-26590
- Supersonic civil airplane study and design: Performance and sonic boom [NASA-CR-197745] p 390 N95-26813
- AIAA Techfest 20 Proceedings [NIAR-94-1] p 367 N95-26941
- Preliminary design problems and solutions for a supersonic oblique all-wing transport aircraft p 390 N95-26942
- An exploratory application of neural networks for airfoil design p 448 N95-26943
- Creating an alternative parameter optimization method (APO) p 375 N95-26946
- Design of a high altitude long endurance aircraft with manufacturing considerations p 391 N95-26947
- Incorporating biplane wing theory into a large, subsonic, all-cargo transport p 391 N95-26956
- The lift-lan aircraft: Lessons learned [NASA-CR-196694] p 392 N95-27143
- Rapid repair of large area damage to contoured aircraft structures p 394 N95-27516
- Wind-tunnel test of the S814 thick root airfoil [DE95-000268] p 376 N95-27541
- JPRS report: Science and technology. Central Eurasia [JPRS-UST-94-022] p 438 N95-27699
- Propulsion system assessment for very high UAV under ERAST [NASA-CR-195469] p 406 N95-27866
- Evaluation of all-electric secondary power for transport aircraft [NASA-CR-189077] p 441 N95-27999
- Performance study for inlet installations [NASA-CR-189714] p 406 N95-28227
- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 3 [NASA-CR-198718] p 420 N95-28266
- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 1 [NASA-CR-198723] p 421 N95-28420
- Benefits and limitations of composites in carrier-based aircraft p 422 N95-28422
- Development of composite carrythrough bulkhead p 423 N95-28438
- Structural design optimization with survivability dependent constraints application: Primary wing box of a multi-role fighter p 398 N95-28440
- Probabilistic design of advanced composite structure p 424 N95-28443
- Probabilistic evaluation of fuselage-type composite structures p 398 N95-28444
- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 2 [NASA-CR-198722] p 424 N95-28462
- Overview of the ACT program p 424 N95-28463
- Designers' unified cost model p 424 N95-28464
- COINS: A composites information database system p 453 N95-28465
- Structural testing of the technology integration box beam p 441 N95-28467
- Technology integration box beam failure study p 441 N95-28468
- Recent progress in NASA Langley textile reinforced composites program p 425 N95-28475
- Advanced textile applications for primary aircraft structures p 399 N95-28476
- Applications of a damage tolerance analysis methodology in aircraft design and production p 426 N95-28483
- Advanced wing design survivability testing and results p 400 N95-28488
- AIRCRAFT DETECTION**
- Aircraft IR/acoustic detection evaluation. Volume 2: Development of a ground-based acoustic sensor system for the detection of subsonic jet-powered aircraft [NASA-CR-189705-VOL-2] p 452 N95-28073
- Performance study for inlet installations [NASA-CR-189714] p 406 N95-28227
- AIRCRAFT ENGINES**
- Aircraft gas turbine emissions challenge [BTN-94-EIX95011441239] p 403 A95-84196
- Nitrogen oxide emissions characteristics of augmented turbofan engines [BTN-94-EIX95011441240] p 403 A95-84197
- Flex cycle combustor development and demonstration [BTN-94-EIX95011441245] p 417 A95-84202
- Development of an aeroderivative gas turbine dry low emissions combustion system [BTN-94-EIX95011441246] p 417 A95-84203
- Charles Norvin Rinek: an early American pioneer in advanced aviation engines [SAE PAPER 930485] p 386 A95-84554
- NASA-Lewis tests Allison ASTOVL nozzle [HTN-95-20603] p 404 A95-84784
- Applying nanostructured materials to future gas turbine engines [HTN-95-11909] p 404 A95-85990
- Design of a high altitude long endurance aircraft with manufacturing considerations p 391 N95-26947
- Prevention and control of inlet unstart using an SR-71 simulation p 367 N95-26948
- Analysis of aircraft engine blade subject to ice impact p 407 N95-28277
- Application of fiber-reinforced bismaleimide materials to aircraft nacelle structures p 397 N95-28278
- AIRCRAFT EQUIPMENT**
- Aircraft nosewheel steering simulation p 412 N95-26944
- AIRCRAFT FUEL SYSTEMS**
- Aircraft fuel system lightning protection design and qualification test procedures development [AD-A288401] p 380 N95-26497
- AIRCRAFT FUELS**
- A numerical model to predict the fate of jettisoned aviation fuel [AD-A289336] p 419 N95-26842
- The effect of aviation fuels containing low amounts of static dissipater additive on electrostatic charge generation [AD-A280075] p 420 N95-28152
- AIRCRAFT GUIDANCE**
- Flight evaluation of GPS/DGPS sensor systems installed in NAL Do228 [NAL-TR-1230] p 382 N95-26585
- AIRCRAFT HAZARDS**
- Further investigations of icing effects on an advanced high-lift multi-element airfoil [NASA-TM-106947] p 381 N95-27762
- A review of falconry as a bird control technique with recommendations for use at the Shuttle Landing Facility, John F. Kennedy Space Center, Florida, USA [NASA-TM-110142] p 381 N95-27859
- AIRCRAFT INDUSTRY**
- Strategy in the commercial aircraft industry in the United States: A comparison of decisionmaking by McDonnell-Douglas and Boeing aircraft companies from 1977-1983 [AD-A288289] p 366 N95-26409
- Surviving the peace. Lessons learned from the aircraft industry in the 1920s and 1930s [AD-A288284] p 366 N95-26455
- AIRCRAFT INSTRUMENTS**
- Flight evaluation of GPS/DGPS sensor systems installed in NAL Do228 [NAL-TR-1230] p 382 N95-26585
- AIRCRAFT LANDING**
- Flightpath synthesis and HUD scaling for V/STOL terminal area operations [NASA-TM-110348] p 383 N95-26587
- An integrated GPS/INS/BARO and radar altimeter system for aircraft precision approach landings [AD-A289280] p 383 N95-26985
- AIRCRAFT MAINTENANCE**
- Maintenance programs [HTN-95-92310] p 365 A95-85354
- Artificial intelligence for turboprop engine maintenance [HTN-95-92313] p 404 A95-85357
- Elements of structural integrity assurance p 387 A95-85896
- Verification of the damage tolerance of a fighter aircraft p 388 A95-85897
- Survey and implementation of commercial manual controllers for a generic telerobotics architecture [AD-A289215] p 449 N95-26990
- AH-1F COBRA rewire program MANPRINT analysis [AD-A289190] p 391 N95-27018
- Composite Repair of Military Aircraft Structures [AGARD-CP-550] p 392 N95-27504
- Bonded composite repair of metallic aircraft components: Overview of Australian activities p 392 N95-27505
- Status of bonded boron/epoxy doublers for military and commercial aircraft structures p 393 N95-27506
- Adhesively bonded composite patch repair of cracked aluminum alloy structures p 393 N95-27507
- Composite repair of metallic airframe: Twenty years of experience p 393 N95-27508
- Bonded composite repair of thin metallic materials: Variable load amplitude and temperature cycling effects p 393 N95-27509
- Design and structural validation of CF116 upper wing skin boron doubler p 393 N95-27510
- A FEAM based methodology for analyzing composite patch repairs of metallic structures p 394 N95-27511
- Structural modification and repair of C-130 wing structure using bonded composites p 394 N95-27512
- Evaluation of patch effectiveness in repairing aircraft components p 394 N95-27513
- Field repair materials for naval aircraft p 394 N95-27514
- On aircraft repair verification of a fighter A/C integrally stiffened fuselage skin p 394 N95-27515
- Rapid repair of large area damage to contoured aircraft structures p 394 N95-27516
- Composite repair of a CF18: Vertical stabilizer leading edge p 395 N95-27517
- Composite repair issues on the CF-18 aircraft p 395 N95-27518
- Repair technology for thermoplastic aircraft structures p 395 N95-27519
- Repair of high temperature composite aircraft structure p 395 N95-27520
- Composite repair of composite structures p 395 N95-27521
- External patch repair of CFRP/honeycomb sandwich p 395 N95-27522
- Scarf joint technique with cocured and precured patches for composite repair p 396 N95-27524
- Composite or metallic bolted repairs on self-stiffened carbon wing panel of the commuter ATR72 design criteria, analysis, verification by test p 396 N95-27525
- Damage occurrence on composites during testing and fleet service: Repair of Airbus aircraft p 396 N95-27526
- Repairs of CFC primary structures p 396 N95-27527
- The development of an engineering standard for composite repairs p 396 N95-27528
- Proceedings of the AIAA/FAA joint symposium on general aviation systems [AD-A289830] p 368 N95-28610
- AIRCRAFT MANEUVERS**
- Nonlinear decoupling control study for aircraft maneuvering flight [HTN-95-71130] p 408 A95-83491
- Part-task simulator evaluations of advanced terrain displays [SAE PAPER 932570] p 401 A95-84567
- AIRCRAFT MODELS**
- Airfoil modification effects on subsonic and transonic pressure distributions and performance for the EA-6B airplane [NASA-TP-3516] p 373 N95-26382
- Simulation model of the integrated flight/propulsion control system, displays, and propulsion system for ASTOVL lift-lan aircraft [NASA-TM-108866] p 405 N95-26412
- Experimental investigation of static and dynamic ground effect on HOPE ALFLEX vehicle [NAL-TR-1236] p 388 N95-26525
- Comparison of fixed wing aircraft algorithms for JANUS [AD-A288503] p 389 N95-26652
- A verification procedure for MSC/NASTRAN Finite Element Models [NASA-CR-4675] p 392 N95-27371
- Modeling of aircraft unsteady aerodynamic characteristics. Part 2: Parameters estimated from wind tunnel data [NASA-TM-110161] p 410 N95-27839
- AIRCRAFT NOISE**
- Aircraft noise prediction program theoretical manual: Rotorcraft System Noise Prediction System (ROTONET), part 4 [NASA-TM-83199-PT-4] p 451 N95-26392
- Evaluation of a doubly-swept blade tip for rotorcraft noise reduction [NASA-CR-189677] p 452 N95-28264
- Noise exposure reduction of advanced high-lift systems [NASA-CR-195077] p 452 N95-28670
- AIRCRAFT PERFORMANCE**
- Pilot rating scale for aircraft handling qualities [HTN-95-42269] p 380 A95-84963
- Supersonic civil airplane study and design: Performance and sonic boom [NASA-CR-197745] p 390 N95-26813
- A comparison of the Neal-Smith and omega Tau function, zeta function and tau function flying qualities criteria [AD-A289503] p 390 N95-26844
- Performance study for inlet installations [NASA-CR-189714] p 406 N95-28227
- Benefits and limitations of composites in carrier-based aircraft p 422 N95-28422

AIRCRAFT PILOTS

The legal status and liability of the copilot, part 2
[HTN-95-A0578] p 452 A95-83158

AIRCRAFT POWER SUPPLIES

Evaluation of all-electric secondary power for transport aircraft
[NASA-CR-189077] p 441 N95-27999

AIRCRAFT PRODUCTION

The analysis of the processing increased weight for pilot production of F-X aircraft
[HTN-95-71133] p 385 A95-83494

Automatic riveting cell for commercial aircraft floor grid assembly
[HTN-95-92309] p 365 A95-85353

Overview of the ACT program
p 424 N95-28463

AIRCRAFT PRODUCTION COSTS

Designers' unified cost model
COINS: A composites information database system
p 424 N95-28464
p 453 N95-28465

Composite fuselage crown panel manufacturing technology
p 399 N95-28474

AIRCRAFT RELIABILITY

Fatigue of aircraft materials; Specialists' Conference, Delft, Netherlands, 1992
[HTN-95-80076] p 387 A95-85892

Test operations procedure (TOP) 7-3-534 airworthiness testing of fixed wing aircraft: Asymmetric power testing
[AD-A289458] p 391 N95-26994

Composite or metallic bolted repairs on self-stiffened carbon wing panel of the commuter ATR72 design criteria, analysis, verification by test
p 396 N95-27525

AIRCRAFT SAFETY

Fibre-Metal laminates
Elements of structural integrity assurance
p 387 A95-85895
p 387 A95-85896

Damage tolerance capability
WINCLR: A computer code for heat transfer and clearance calculation in a compressor
[NASA-CR-195436] p 366 N95-26363

Aircraft accident report: Controlled collision with Terrain Transportes Aereos Ejecutivos, S.A. (TAESA) Learjet 25D, XA-BBA Dulles International Airport Chantilly, Virginia, June 18, 1994
[NTSB/AAR-95/02] p 380 N95-26498

AIAA Techfest 20 Proceedings
[NIAR-94-1] p 367 N95-26941

Prevention and control of inlet unstart using an SR-71 simulation
p 367 N95-26948

Precision landing system mathematical modeling study report for Andrews Air Force Base, runway 19L, Camp Springs, MD
[AD-A289015] p 384 N95-27903

AIRCRAFT SPIN

T-45A high angle attack testing
[HTN-95-81499] p 386 A95-85213

AIRCRAFT STABILITY

Robust longitudinal axis flight control for an aircraft with thrust vectoring
[BTN-95-EIX95122538875] p 408 A95-83000

An easy way to analyze longitudinal and lateral-directional trim problems with AEO or OEI
p 409 N95-26949

AIRCRAFT STRUCTURES

Forming and bonding techniques for high-strength aluminum alloys
[HTN-95-20605] p 418 A95-84786

Automatic riveting cell for commercial aircraft floor grid assembly
[HTN-95-92309] p 365 A95-85353

Aircraft stripping and painting
[HTN-95-92311] p 365 A95-85355

Fatigue of aircraft materials; Specialists' Conference, Delft, Netherlands, 1992
[HTN-95-80076] p 387 A95-85892

Status and prospects for aluminium-lithium alloys in aircraft structures
p 387 A95-85893

Fatigue of aircraft materials and structures
p 387 A95-85894
p 387 A95-85895

Fibre-Metal laminates
Elements of structural integrity assurance
p 387 A95-85896

Verification of the damage tolerance of a fighter aircraft
p 388 A95-85897

Damage tolerance capability
A verification procedure for MSC/NASTRAN Finite Element Models
[NASA-CR-4675] p 392 N95-27371

Composite Repair of Military Aircraft Structures
[AGARD-CP-550] p 392 N95-27504

Bonded composite repair of metallic aircraft components: Overview of Australian activities
p 392 N95-27505

Status of bonded boron/epoxy doublers for military and commercial aircraft structures
p 393 N95-27506

Adhesively bonded composite patch repair of cracked aluminum alloy structures
p 393 N95-27507

Design and structural validation of CF116 upper wing skin boron doubler
p 393 N95-27510

A FEAM based methodology for analyzing composite patch repairs of metallic structures
p 394 N95-27511

Structural modification and repair of C-130 wing structure using bonded composites
p 394 N95-27512

Evaluation of patch effectiveness in repairing aircraft components
p 394 N95-27513

Rapid repair of large area damage to contoured aircraft structures
p 394 N95-27516

Repair technology for thermoplastic aircraft structures
p 395 N95-27519

Repair of high temperature composite aircraft structure
p 395 N95-27520

External patch repair of CFRP/honeycomb sandwich
p 395 N95-27522

Scar joint technique with cocured and precured patches for composite repair
p 396 N95-27524

Damage occurrence on composites during testing and fleet service: Repair of Airbus aircraft
p 396 N95-27526

Repairs of CFC primary structures
p 396 N95-27527

The development of an engineering standard for composite repairs
p 396 N95-27528

Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 3
[NASA-CR-198718] p 420 N95-28266

Process and control systems for composite manufacturing
p 420 N95-28267

Advanced tow placement of composite fuselage structure
p 420 N95-28271

Through-the Thickness(R) braided composites for aircraft applications
p 421 N95-28273

Resin transfer molding of textile preforms for aircraft structural applications
p 421 N95-28276

Application of fiber-reinforced bismaleimide materials to aircraft nacelle structures
p 397 N95-28278

Analysis techniques for the prediction of springback in formed and bonded composite components
p 421 N95-28289

The effect of material heterogeneity in curved composite beams for use in aircraft structures
p 422 N95-28426

Vibrational behavior of adaptive aircraft wing structures modelled as composite thin-walled beams
p 423 N95-28435

Development of composite carrythrough bulkhead
p 423 N95-28438

Probabilistic design of advanced composite structure
p 424 N95-28443

Probabilistic evaluation of fuselage-type composite structures
p 398 N95-28444

Navy composite maintenance and repair experience
p 424 N95-28446

Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 2
[NASA-CR-198722] p 424 N95-28462

Overview of the ACT program
COINS: A composites information database system
p 424 N95-28463
p 453 N95-28465

Composite fuselage shell structures research at NASA Langley Research Center
p 425 N95-28466

Technology integration box beam failure study
p 441 N95-28468

Development of stitched/RTM composite primary structures
p 425 N95-28469

Recent progress in NASA Langley textile reinforced composites program
p 425 N95-28475

Advanced textile applications for primary aircraft structures
p 399 N95-28476

Comparison of resin film infusion, resin transfer molding, and consolidation of textile preforms for primary aircraft structure
p 425 N95-28477

Characterization and manufacture of braided composites for large commercial aircraft structures
p 426 N95-28478

Application of damage tolerance methodology in certification of the Piaggio P-180 Avanti
p 399 N95-28480

Effect of low-speed impact damage and damage location on behavior of composite panels
p 426 N95-28481

AIRCRAFT SURVIVABILITY

Structural design optimization with survivability dependent constraints application: Primary wing box of a multi-role fighter
p 398 N95-28440

Advanced wing design survivability testing and results
p 400 N95-28488

AIRCRAFT TIRES

Aircraft nosewheel steering simulation
p 412 N95-26944

AIRDROPS

The performance of cargo airdrop systems using g-12E parachutes: Statistical determination of minimum altitude
[AD-A291666] p 381 N95-28454

AIRFOIL OSCILLATIONS

Reattachment studies of an oscillating airfoil dynamic stall flowfield
[HTN-95-51660] p 432 A95-85042

Explicit Kutta condition for an unsteady two-dimensional constant potential panel method
[HTN-95-51679] p 433 A95-85061

Nonlinear dynamics and aeroelasticity of rotorcraft in forward flight
[AD-A291714] p 400 N95-28504

AIRFOIL PROFILES

Precision requirement for potential-based panel methods
[HTN-95-51666] p 433 A95-85048

Force and moment on a Joukowski profile in the presence of point vortices
[BTN-95-EIX95262694298] p 434 A95-85469

An exploratory application of neural networks for airfoil design
p 448 N95-26943

Comparative wind tunnel tests of NACA 23024 airfoils with several aileron and spoiler configurations
p 376 N95-27976

Comparative wind tunnel test at high Reynolds numbers of NACA 64 621 airfoils with two aileron configurations
p 377 N95-27977

Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils
[NASA-TP-3496] p 378 N95-28674

AIRFOILS

Direct boundary integral equations method to subsonic flow with circulation past thin airfoils in ground effect
[BTN-95-EIX95242673940] p 365 A95-82224

On the influence of time-varying flow velocity on unsteady aerodynamics
[HTN-95-61073] p 369 A95-83657

Precision requirement for potential-based panel methods
[HTN-95-51666] p 433 A95-85048

Explicit Kutta condition for an unsteady two-dimensional constant potential panel method
[HTN-95-51679] p 433 A95-85061

Predicting stall and post-stall behavior of airfoils at low mach numbers
[BTN-95-EIX95262694297] p 365 A95-85468

Computational analysis of buffet alleviation in viscous transonic flow over a porous airfoil
[BTN-95-EIX95262694321] p 366 A95-85492

Effect of Reynolds number and turbulence on airfoil aerodynamics at -90-degree incidence
[HTN-95-42320] p 370 A95-86149

Reduction of blade-vortex interaction noise through porous leading edge
[HTN-95-42324] p 371 A95-86153

Compressible Navier-Stokes computations of multielement airfoil flows using multiblock grids
[HTN-95-42327] p 371 A95-86156

Interferometric investigations of compressible dynamic stall over a transiently pitching airfoil
[HTN-95-42338] p 372 A95-86167

High angle-of-attack airfoil performance improvement by internal acoustic excitation
[HTN-95-42347] p 372 A95-86176

Airfoil modification effects on subsonic and transonic pressure distributions and performance for the EA-6B airplane
[NASA-TP-3516] p 373 N95-26382

Computational fluid dynamics and transonic flow
[AD-A288962] p 436 N95-26405

An exploratory application of neural networks for airfoil design
p 448 N95-26943

Creating an alternative parameter optimization method (APO)
p 375 N95-26946

The near-wake flow behavior of an oscillating airfoil with modified trailing edge
p 375 N95-26953

Wind-tunnel test of the S814 thick root airfoil
[DE95-000268] p 376 N95-27541

Further investigations of icing effects on an advanced high-lift multi-element airfoil
[NASA-TM-106947] p 381 N95-27762

Horizontal axis wind turbine post stall airfoil characteristics synthesis
p 376 N95-27974

AIRFRAMES

Hypersonic trajectory control of aerospace plane with integrated SCRAMJET engine
p 413 A95-82384

Suppressor of oscillations in airframe cavities
[AD-D017265] p 388 N95-26507

Composite repair of metallic airframe: Twenty years of experience
p 393 N95-27508

Resin transfer molding of textile preforms for aircraft structural applications
p 421 N95-28276

Applications of a damage tolerance analysis methodology in aircraft design and production
p 426 N95-28483

NASA-ACEE/Boeing 737 graphite-epoxy horizontal stabilizer service
p 400 N95-28489

AIRLINE OPERATIONS

- Rotorcraft crashworthy airframe and fuel system technology development program
[AD-A289986] p 382 N95-28630
- AIRLINE OPERATIONS**
Maintenance programs
[HTN-95-92310] p 365 A95-85354
An integrated GPS/INS/BARO and radar altimeter system for aircraft precision approach landings
[AD-A289280] p 383 N95-26985
- AIRPORT TOWERS**
Air traffic operational inventory CY 1994
[AD-A288281] p 382 N95-26454
- AIRPORTS**
The 1994 updated National Airspace System performance assessment for year 2005
[AD-A288652] p 380 N95-26485
- AIRSPACE**
The 1994 updated National Airspace System performance assessment for year 2005
[AD-A288652] p 380 N95-26485
Unmanned aerial vehicles, 1994 master plan
[AD-A291628] p 398 N95-28411
- AIRSPEED**
Advanced formation flight control
[AD-A289271] p 409 N95-26981
- ALBEDO**
Air truth validation of cloud albedo estimated from NOAA advanced very high resolution radiometer data
[HTN-95-A1021] p 443 A95-84526
- ALGORITHMS**
Accuracy and efficiency assessments for a weak statement CFD algorithm for high-speed aerodynamics
[BTN-94-EIX95011441238] p 370 A95-84195
Compressible Navier-Stokes computations of multielement airfoil flows using multiblock grids
[HTN-95-42327] p 371 A95-86156
Using the Liou-Steffen algorithm for the Euler and Navier-Stokes equations
[HTN-95-42348] p 373 A95-86177
A non-iterative grid deformation algorithm for computational fluid dynamics for aeroelasticity
[AD-A288298] p 436 N95-26418
Flightpath synthesis and HUD scaling for V/STOL terminal area operations
[NASA-TM-110348] p 383 N95-26587
Comparison of fixed wing aircraft algorithms for JANUS
[AD-A288503] p 389 N95-26652
Development of an upwind, finite-volume code with finite-rate chemistry
[NASA-CR-197747] p 374 N95-26760
Implementation and demonstration of a multiple model adaptive estimation failure detection system for the F-16
[AD-A289301] p 391 N95-27042
Modeling of aircraft unsteady aerodynamic characteristics. Part 2: Parameters estimated from wind tunnel data
[NASA-TM-110161] p 410 N95-27839
The applicability of turbulence models to aerodynamic and propulsion flowfields at McDonnell-Douglas Aerospace
p 439 N95-27886
Local design optimization for composite transport fuselage crown panels
p 398 N95-28473
- ALPS MOUNTAINS (EUROPE)**
Data processing and mapping in airborne radiometric surveys
[HTN-95-51587] p 442 A95-83591
- ALTERNATIVES**
Life cycle costs of alternatives for F-16 printed circuit board diagnosis equipment
[AD-A288744] p 401 N95-28586
- ALTIMETERS**
An in situ evaluation of TOPEX/Poseidon altimetric measurements versus measurements made by moorings and inverted echo sounders for sea surface height
[NASA-CR-198621] p 447 N95-27805
- ALTIMETRY**
An in situ evaluation of TOPEX/Poseidon altimetric measurements versus measurements made by moorings and inverted echo sounders for sea surface height
[NASA-CR-198621] p 447 N95-27805
- ALUMINUM ALLOYS**
Flight simulation fatigue crack growth testing of aluminum alloys
[HTN-95-00652] p 418 A95-84731
Forming and bonding techniques for high-strength aluminum alloys
[HTN-95-20605] p 418 A95-84786
- ALUMINUM-LITHIUM ALLOYS**
Status and prospects for aluminum-lithium alloys in aircraft structures
p 387 A95-85893
- AMORPHOUS MATERIALS**
Repair technology for thermoplastic aircraft structures
p 395 N95-27519

AMPHIBIOUS VEHICLES

- Air cushioned landing craft (LCAC) based ship to shore movement simulation: A decision aid for the amphibious commander. A (SMMAT) application
[AD-A289635] p 436 N95-26722

ANALYSIS (MATHEMATICS)

- Non-linear analysis provides new insights into impact damage of composite structures
[HTN-95-42368] p 418 A95-86197

ANECHOIC CHAMBERS

- Anechoic wind tunnel study of turbulence effects on wind turbine broadband noise
p 451 N95-27992

ANGLE OF ATTACK

- Air data sensors for atmospheric reentry flight test of winged space vehicle
p 413 A95-82412
Hypersonic thermal protection with mass injection at angle of attack
p 414 A95-82414
Transition correlations in three-dimensional boundary layers
[HTN-95-51648] p 432 A95-85030

- Reattachment studies of an oscillating airfoil dynamic stall flowfield
[HTN-95-51660] p 432 A95-85042

T-45A high angle attack testing

- [HTN-95-81499] p 386 A95-85213

- Predicting stall and post-stall behavior of airfoils at low mach numbers
[BTN-95-EIX95262694297] p 365 A95-85468

- Wind-tunnel tests of an inclined cylinder having helical grooves
[BTN-95-EIX95262694306] p 411 A95-85477

- High angle-of-attack airfoil performance improvement by internal acoustic excitation
[HTN-95-42347] p 372 A95-86176

- Numerical simulation of the flow about the F-18 HARV at high angle of attack
[NASA-CR-197755] p 374 N95-26735

ANGULAR VELOCITY

- Electro-hydrostatic actuator controller design using quantitative feedback theory
[AD-A289220] p 409 N95-26957

- Preliminary analysis of dynamic stall effects on a 91-meter wind turbine rotor
p 376 N95-27975

ANNULAR FLOW

- Near field of a coaxial jet with and without axial excitation
[HTN-95-42332] p 372 A95-86161

ANOMALIES

- Geophex airborne unmanned survey system
[DE95-007566] p 392 N95-27440

- APPLICATIONS PROGRAMS (COMPUTERS)**
GETRAN: A generic, modularly structured computer code for simulation of dynamic behavior of aero- and power generation gas turbine engines
[BTN-94-EIX95011441241] p 431 A95-84198

- An evaluation of the Software Through Pictures/T Tool (SIP/T) for the Software Support Activity (SSA)
[AD-A288822] p 447 N95-26348

- WINCLR: A computer code for heat transfer and clearance calculation in a compressor
[NASA-CR-195436] p 366 N95-26363

- User documentation of the CTA program
[AD-A289508] p 375 N95-26854

- EASY-SIM: A visual simulation system software architecture with an Ada 9X application framework
[AD-A289325] p 448 N95-26895

- An exploratory application of neural networks for airfoil design
p 448 N95-26943

- Determining GPS average performance metrics
p 383 N95-27791

- Development of a TECS control-law for the lateral directional axis of the McDonnell Douglas F-15 Eagle
[AD-A289771] p 410 N95-28598

APPROACH CONTROL

- Development of a coding form for approach control/pilot voice communications
[DOT/FAA/AM-95/15] p 384 N95-28540

APPROXIMATION

- Contribution of thermal radiation to the temperature profile of ceramic composite materials
[BTN-94-EIX95011441252] p 417 A95-84209

ARAMID FIBER COMPOSITES

- Proof test methodology for composites
p 424 N95-28445

ARC JET ENGINES

- Life evaluation of a low power arcjet thruster
p 403 A95-82337

ARCHITECTURE (COMPUTERS)

- EASY-SIM: A visual simulation system software architecture with an Ada 9X application framework
[AD-A289325] p 448 N95-26895

- An exploratory application of neural networks for airfoil design
p 448 N95-26943

- Advanced flight computer. Special study
[NASA-CR-198165] p 449 N95-27246

- Design of a real-time wind turbine simulator using a custom parallel architecture
p 449 N95-27979

ARCTIC REGIONS

- An overview of the EASOE campaign
[HTN-95-00702] p 443 A95-86272

- Aircraft measurements of CLO and HCL during EASOE 1991/92
p 444 A95-86291

- An overview of millimeter-wave spectroscopic measurements of chlorine monoxide at Thule, Greenland, February-March, 1992: Vertical profiles, diurnal variation, and longer-term trends
[HTN-95-00721] p 444 A95-86292

- Two dimensional stratospheric aerosol distributions during EASOE
[HTN-95-00726] p 444 A95-86296

- Airborne measurements during the European Arctic Stratospheric Ozone Experiment column amounts of HNO3 and O3 derived from FTIR emission sounding
[HTN-95-00742] p 445 A95-86312

- Airborne measurements during the European Arctic Stratospheric Ozone Experiment: Observation of OCIO
[HTN-95-00745] p 445 A95-86315

- Airborne measurements during the Arctic stratospheric experiment: Observation of O3 and NO2
[HTN-95-00748] p 445 A95-86318

- ARMED FORCES (UNITED STATES)**
Utilization of composite materials by the US Army: A look ahead
p 421 N95-28421

ARTIFICIAL GRAVITY

- Study on a scheme for the prolongation of microgravity time of balloon-borne drop capsule
p 414 A95-82515

ARTIFICIAL INTELLIGENCE

- Intelligent flight trainer for initial rotary wing training
[SAE PAPER 932536] p 386 A95-84558

- Artificial intelligence for turboprop engine maintenance
[HTN-95-92313] p 404 A95-85357

- Design and synthesis of a real-time controller for an unmanned air vehicle
[AD-A289134] p 408 N95-26555

- Digital systems validation. Chapter 20 Artificial Intelligence with applications for aircraft. Handbook, volume 2
[AD-A288492] p 448 N95-26638

- Operator modeling in commercial aviation: Cognitive models, intelligent displays, and pilot's assistants
[NASA-CR-198609] p 401 N95-28203

ASCENT

- Variational principles for ascent shapes of large scientific balloons
[BTN-95-EIX95262694320] p 387 A95-85491

ASIA

- Asian Aeronautics: Technology acquisition drives industry development. Report to Congressional requesters
[GAO/NSIAD-94-140] p 367 N95-26817

ASTRONAUTICS

- Aeronautical engineering: A continuing bibliography with indexes (supplement 318)
[NASA-SP-7037(318)] p 367 N95-27543

ASTROPHYSICS

- Airborne geophysics and precise positioning: Scientific issues and future directions
[LC-94-68678] p 446 N95-27156

ATLANTIC OCEAN

- Fractal properties of whitecaps
[HTN-95-92121] p 443 A95-83827

ATMOSPHERIC CHEMISTRY

- An overview of the EASOE campaign
[HTN-95-00702] p 443 A95-86272

- Aircraft measurements of CLO and HCL during EASOE 1991/92
[HTN-95-00721] p 444 A95-86291

- Airborne measurements during the European Arctic Stratospheric Ozone Experiment column amounts of HNO3 and O3 derived from FTIR emission sounding
[HTN-95-00742] p 445 A95-86312

- Airborne measurements during the European Arctic Stratospheric Ozone Experiment: Observation of OCIO
[HTN-95-00745] p 445 A95-86315

ATMOSPHERIC CIRCULATION

- Two dimensional stratospheric aerosol distributions during EASOE
[HTN-95-00726] p 444 A95-86296

ATMOSPHERIC ENTRY

- Research and development of thermal protection system of HOPE re-entry vehicle
p 413 A95-82358

- Studies on gain performance of a combustion driven CO2 gas dynamic laser
p 428 A95-82679

ATMOSPHERIC MODELS

- A mathematical analysis of the Janus combat simulation weather effects models and sensitivity analysis of sky-to-ground brightness ratio on target detection
[AD-A289629] p 446 N95-26858

ATMOSPHERIC TEMPERATURE

- Effects of a polar stratosphere cloud parameterization on ozone depletion due to stratospheric aircraft in a two-dimensional model
[HTN-95-A1038] p 443 A95-84543
- Two dimensional stratospheric aerosol distributions during EASOE
[HTN-95-00726] p 444 A95-86296
- Airborne lidar observation of mountain-wave-induced polar stratospheric clouds during EASOE
[HTN-95-00738] p 444 A95-86308

ATTACK AIRCRAFT

- AH-1F COBRA rewire program MANPRINT analysis
[AD-A289190] p 391 N95-27018

ATTITUDE (INCLINATION)

- Whirl plus tilt
[DE95-007948] p 452 N95-28108

AUSTRALIA

- Comparison of fixed wing aircraft algorithms for JANUS
[AD-A288503] p 389 N95-26652
- A review of Australian and New Zealand investigations on aeronautical fatigue during the period Apr. 1993 - Mar. 1995
[AR-009-202] p 397 N95-27918

AUTOCALVES

- ACT/ICAPS: Thermoplastic composite activities
p 421 N95-28274

AUTOCORRELATION

- Prediction of fatigue crack growth under constant amplitude and random loading using specimens with multiple cracks
[AD-A291614] p 397 N95-28409

AUTOMATIC CONTROL

- Automatic riveting cell for commercial aircraft floor grid assembly
[HTN-95-92309] p 365 A95-85353
- Aircraft stripping and painting
[HTN-95-92311] p 365 A95-85355
- Operator modeling in commercial aviation: Cognitive models, intelligent displays, and pilot's assistants
[NASA-CR-198609] p 401 N95-28203

AUTOMATIC FLIGHT CONTROL

- Air data sensors for atmospheric reentry flight test of winged space vehicle
p 413 A95-82412
- Development of a TECS control-law for the lateral directional axis of the McDonnell Douglas F-15 Eagle
[AD-A289771] p 410 N95-28598

AUTOMATIC PILOTS

- Advanced formation flight control
[AD-A289271] p 409 N95-26981

AUTOMATIC TEST EQUIPMENT

- Life cycle costs of alternatives for F-16 printed circuit board diagnosis equipment
[AD-A288744] p 401 N95-28586

AVIONICS

- Micro-time stress measurement device development
[AD-A289511] p 448 N95-26845
- An analysis of the KC-135 three-person cockpit
[AD-A289540] p 390 N95-26873

AXES OF ROTATION

- Horizontal axis wind turbine post stall airfoil characteristics synthesis
p 376 N95-27974
- A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines
p 439 N95-27980
- Measurement and prediction of broadband noise from large horizontal axis wind turbine generators
p 451 N95-27990

AXIAL FLOW

- Aeroelastic stability of cascades in turbomachinery
[HTN-95-61156] p 405 A95-86255
- A general theory of two- and three-dimensional rotational flow in subsonic and transonic turbomachines
[NASA-CR-4496] p 377 N95-28003

B

BACKSCATTERING

- Analysis of backscattering from wing and fuselage joints
[HTN-95-71134] p 430 A95-83495

BALANCING

- Balanced on air aircraft
[AD-D017251] p 389 N95-26537

BALLISTIC RANGES

- An experimental study on radiation from strong shock layer
p 368 A95-82421

BALLOON FLIGHT

- Variational principles for ascent shapes of large scientific balloons
[BTN-95-EIX95262694320] p 387 A95-85491

BALLOON-BORNE INSTRUMENTS

- Study on a scheme for the prolongation of microgravity time of balloon-borne drop capsule
p 414 A95-82515

BEADS

- Active open-loop control of particle dispersion in round jets
[HTN-95-42334] p 372 A95-86163

BEAMS (SUPPORTS)

- Vibration measurements on rotating machinery using laser Doppler velocimetry
[BTN-94-EIX95011440597] p 429 A95-82986
- Equivalent beam-column analysis of guyed towers
[BTN-95-EIX95262696644] p 435 A95-85519
- Vibrational behavior of adaptive aircraft wing structures modelled as composite thin-walled beams
p 423 N95-28435

BEARINGS

- The effects of wall perturbations on thermo-turbulent Couette flow
[HTN-95-92255] p 434 A95-85299
- Bearing defect signature analysis using advanced nonlinear signal analysis in a controlled environment
[NASA-TM-108491] p 441 N95-28364

BELL AIRCRAFT

- Rotorcraft crashworthy airframe and fuel system technology development program
[AD-A289986] p 382 N95-28630

BEND TESTS

- On aircraft repair verification of a fighter A/C integrally stiffened fuselage skin
p 394 N95-27515

BENDING

- The dynamic nature of rotor thermal bending due to unsteady lubricant shearing within a bearing
[HTN-95-42091] p 430 A95-83857
- Analysis of composite structures with delaminations under combined bending and compression
p 422 N95-28429

BENDING MOMENTS

- Technology integration box beam failure study
p 441 N95-28468

BIBLIOGRAPHIES

- Aeronautical engineering: A continuing bibliography with indexes (supplement 318)
[NASA-SP-7037(318)] p 367 N95-27543

BIONICS

- Human factors issues in aircraft cabin design
[SAE PAPER 932527] p 386 A95-84556

BIOTECHNOLOGY

- JTEC/WTEC annual report and program summary: 1993/94
[NASA-CR-198563] p 454 N95-28038

BIPLANES

- Full span flaperons for a biplane
p 391 N95-26954
- Incorporating biplane wing theory into a large, subsonic, all-cargo transport
p 391 N95-26956

BIRD-AIRCRAFT COLLISIONS

- Development of repair processes and sources for C/KC-135 aircraft windows/windshields
[AD-A288348] p 367 N95-26629
- A review of falconry as a bird control technique with recommendations for use at the Shuttle Landing Facility, John F. Kennedy Space Center, Florida, USA
[NASA-TM-110142] p 381 N95-27859

BIRDS

- A review of falconry as a bird control technique with recommendations for use at the Shuttle Landing Facility, John F. Kennedy Space Center, Florida, USA
[NASA-TM-110142] p 381 N95-27859

BISMALEIMIDE

- Application of fiber-reinforced bismaleimide materials to aircraft nacelle structures
p 397 N95-28278

BLADE SLAP NOISE

- Flow structure generated by perpendicular blade vortex interaction and implications for helicopter noise predictions
[NASA-CR-198590] p 377 N95-28193
- Evaluation of a doubly-swept blade tip for rotorcraft noise reduction
[NASA-CR-189677] p 452 N95-28264

BLADE TIPS

- Effects of blade tip shape on dynamics, cost, weight, aerodynamic performance, and aeroelastic response
[HTN-95-61074] p 369 A95-83658
- Evaluation of a doubly-swept blade tip for rotorcraft noise reduction
[NASA-CR-189677] p 452 N95-28264

BLADE-VORTEX INTERACTION

- A higher harmonic control test in the DNW to reduce impulsive BVI noise
[HTN-95-61071] p 385 A95-83655
- Reduction of blade-vortex interaction noise through porous leading edge
[HTN-95-42324] p 371 A95-86153
- Comparative performance tests on the Mod-2, 2.5-mW wind turbine with and without vortex generators
p 377 N95-27978
- Measurement and prediction of broadband noise from large horizontal axis wind turbine generators
p 451 N95-27990

- Flow structure generated by perpendicular blade vortex interaction and implications for helicopter noise predictions
[NASA-CR-198590] p 377 N95-28193

- Evaluation of a doubly-swept blade tip for rotorcraft noise reduction
[NASA-CR-189677] p 452 N95-28264

BLOCKING

- Precision landing system mathematical modeling study report for Andrews Air Force Base, runway 19L, Camp Springs, MD
[AD-A289015] p 384 N95-27903

BLOWING

- Computational analysis of forebody tangential slot blowing on the high alpha research vehicle
[NASA-CR-197754] p 389 N95-26591
- Performance characterization of a highly-offset diffuser with and without blowing vortex generator jets
[AD-A289334] p 375 N95-26901

BLUFF BODIES

- Effects of three-dimensional imposed 3-D disturbances on bluff-body near wake flows
[AD-A289553] p 374 N95-26757

BODIES OF REVOLUTION

- Crossflow topology of vortical flows
[HTN-95-51664] p 432 A95-85046

BODY-WING CONFIGURATIONS

- Aeroelasticity of wing and wing-body configurations on parallel computers
[NASA-CR-197756] p 389 N95-26590
- Preliminary design problems and solutions for a supersonic oblique all-wing transport aircraft
p 390 N95-26942

BOEING AIRCRAFT

- Strategy in the commercial aircraft industry in the United States: A comparison of decisionmaking by McDonnell-Douglas and Boeing aircraft companies from 1977-1983
[AD-A288289] p 366 N95-26409
- Report to Congressional Committees. Comanche Helicopter: Testing needs to be completed prior to production decisions
[GAO/NSIAD-95-112] p 397 N95-27910

BOEING 737 AIRCRAFT

- NASA-ACEE/Boeing 737 graphite-epoxy horizontal stabilizer service
p 400 N95-28489

BOEING 747 AIRCRAFT

- Numerical simulation of the SOFIA flow field
[NASA-CR-197757] p 436 N95-26589

BOMBER AIRCRAFT

- Performance study for inlet installations
[NASA-CR-189714] p 406 N95-28227

BONDED JOINTS

- Design and structural validation of CF116 upper wing skin boron doubler
p 393 N95-27510
- Composite repair issues on the CF-18 aircraft
p 395 N95-27518
- The development of an engineering standard for composite repairs
p 396 N95-27528

BONDING

- Status of bonded boron/epoxy doublers for military and commercial aircraft structures
p 393 N95-27506
- Evaluation of patch effectiveness in repairing aircraft components
p 394 N95-27513
- Repair technology for thermoplastic aircraft structures
p 395 N95-27519

BORON FIBERS

- Composite repair of metallic airframe: Twenty years of experience
p 393 N95-27508

BORON REINFORCED MATERIALS

- Adhesively bonded composite patch repair of cracked aluminum alloy structures
p 393 N95-27507
- Bonded composite repair of thin metallic materials: Variable load amplitude and temperature cycling effects
p 393 N95-27509

BORON-EPOXY COMPOSITES

- Bonded composite repair of metallic aircraft components: Overview of Australian activities
p 392 N95-27505
- Status of bonded boron/epoxy doublers for military and commercial aircraft structures
p 393 N95-27506
- Bonded composite repair of thin metallic materials: Variable load amplitude and temperature cycling effects
p 393 N95-27509
- Design and structural validation of CF116 upper wing skin boron doubler
p 393 N95-27510
- Structural modification and repair of C-130 wing structure using bonded composites
p 394 N95-27512

BOUNDARIES

- A non-iterative grid deformation algorithm for computational fluid dynamics for aeroelasticity
[AD-A288298] p 436 N95-26418

BOUNDARY CONDITIONS

- Nonreflective boundary conditions for high-order methods
[HTN-95-42328] p 371 A95-86157

BOUNDARY INTEGRAL METHOD

BOUNDARY INTEGRAL METHOD

Direct boundary integral equations method to subsonic flow with circulation past thin airfoils in ground effect [BTN-95-EIX95242673940] p 365 A95-82224

BOUNDARY LAYER CONTROL

Performance characterization of a highly-offset diffuser with and without blowing vortex generator jets [AD-A289334] p 375 N95-26901
Comparative performance tests on the Mod-2, 2.5-mW wind turbine with and without vortex generators p 377 N95-27978

BOUNDARY LAYER EQUATIONS

Predicting stall and post-stall behavior of airfoils at low mach numbers [BTN-95-EIX95262694297] p 365 A95-85468
Supersonic coaxial jet noise predictions [NASA-TM-106917] p 451 N95-26801

BOUNDARY LAYER FLOW

Instability of three-dimensional boundary layers due to streamline curvature [HTN-95-61070] p 430 A95-83654
Free convection past a uniform flux surface inclined at a small angle to the horizontal [HTN-95-42213] p 430 A95-84029
Transition correlations in three-dimensional boundary layers [HTN-95-51648] p 432 A95-85030
Boundary layer studies over an S-blade [HTN-95-92261] p 434 A95-85305
Predicting stall and post-stall behavior of airfoils at low mach numbers [BTN-95-EIX95262694297] p 365 A95-85468
High angle-of-attack airfoil performance improvement by internal acoustic excitation [HTN-95-42347] p 372 A95-86176
Response of multi-panel assembly to noise from a jet in forward motion [NASA-CR-198164] p 442 N95-28673

BOUNDARY LAYER SEPARATION

Performance characterization of a highly-offset diffuser with and without blowing vortex generator jets [AD-A289334] p 375 N95-26901

BOUNDARY LAYER STABILITY

Instability of three-dimensional boundary layers due to streamline curvature [HTN-95-61070] p 430 A95-83654
Quiet-flow Ludweig tube for high-speed transition research [BTN-95-EIX95262694309] p 370 A95-85480

BOUNDARY LAYER TRANSITION

Multiple instabilities of three-dimensional boundary layers along a concave wall [HTN-95-71126] p 429 A95-83487
Transition correlations in three-dimensional boundary layers [HTN-95-51648] p 432 A95-85030
Surface interference in Rayleigh scattering measurements near forebodies [HTN-95-51670] p 433 A95-85052
Quiet-flow Ludweig tube for high-speed transition research [BTN-95-EIX95262694309] p 370 A95-85480

BOUNDARY LAYERS

Transport phenomena and interfacial kinetics in multiphase combustion systems [AD-A288297] p 418 N95-26417

BOX BEAMS

C-130 Advanced Technology Center wing box conceptual design/cost study p 423 N95-28437
Structural testing of the technology integration box beam p 441 N95-28467
Technology integration box beam failure study p 441 N95-28468

BRAIDED COMPOSITES

Through-the Thickness(R) braided composites for aircraft applications p 421 N95-28273
Characterization and manufacture of braided composites for large commercial aircraft structures p 426 N95-28478

BREADBOARD MODELS

Characterization of corrosion and development of a breadboard of a D sight aircraft inspection system, phase 1 [AD-A288347] p 380 N95-26527

BROADBAND

Measurement and prediction of broadband noise from large horizontal axis wind turbine generators p 451 N95-27990
Anechoic wind tunnel study of turbulence effects on wind turbine broadband noise p 451 N95-27992

BUCKLING

Shear buckling response of tailored composite plates [HTN-95-51680] p 418 A95-85062
Effect of low-speed impact damage and damage location on behavior of composite panels p 426 N95-28481

Fundamental concepts in the suppression of delamination buckling by stitching p 426 N95-28486
Damage tolerance of a geodesically stiffened advanced composite structural concept for aircraft structural applications p 399 N95-28487

BUDGETING

Cuts endanger airborne research --- NASA Ames Research Center Reorganization [HTN-95-20602] p 443 A95-84783

BUFFETING

Computational analysis of buffet alleviation in viscous transonic flow over a porous airfoil [BTN-95-EIX95262694321] p 366 A95-85492

BULKHEADS

Development of composite carrythrough bulkhead p 423 N95-28438

BUOYANCY

Stationary premixed flames in spherical and cylindrical geometries [HTN-95-42336] p 418 A95-86165

C

C-130 AIRCRAFT

C-130 Advanced Technology Center wing box conceptual design/cost study p 423 N95-28437

C-135 AIRCRAFT

Development of repair processes and sources for C/KC-135 aircraft windows/windshields [AD-A288348] p 367 N95-26629
An analysis of the KC-135 three-person cockpit [AD-A289540] p 390 N95-26873
Two-phase flow research using the learjet apparatus [NASA-TM-106814] p 438 N95-27854

CALIBRATING

Aircraft fuel system lightning protection design and qualification test procedures development [AD-A288401] p 380 N95-26497

CANADA

Characterization of corrosion and development of a breadboard of a D sight aircraft inspection system, phase 1 [AD-A288347] p 380 N95-26527

CANARD CONFIGURATIONS

Design and testing of low sonic boom configurations and an oblique all-wing supersonic transport [NASA-CR-197744] p 389 N95-26651

CAPACITORS

A hybrid vehicle evaluation code and its application to vehicle design. Revision 1 [DE95-008053] p 441 N95-28029

CAPE KENNEDY LAUNCH COMPLEX

A review of falconry as a bird control technique with recommendations for use at the Shuttle Landing Facility, John F. Kennedy Space Center, Florida, USA [NASA-TM-110142] p 381 N95-27859

CARBON DIOXIDE

Stationary premixed flames in spherical and cylindrical geometries [HTN-95-42336] p 418 A95-86165

CARBON DIOXIDE LASERS

Studies on gain performance of a combustion driven CO2 gas dynamic laser p 428 A95-82679

CARBON FIBER REINFORCED PLASTICS

Adhesively bonded-composite patch repair of cracked aluminum alloy structures p 393: N95-27507
External patch repair of CFRP/honeycomb sandwich p 395 N95-27522

CARBON FIBERS

Composite or metallic bolted repairs on self-stiffened carbon wing panel of the commuter ATR72 design criteria, analysis, verification by test p 396 N95-27525

CARBON-CARBON COMPOSITES

R & D on HOPE structure p 413 A95-82355

CARGO

The performance of cargo airdrop systems using g-12E parachutes: Statistical determination of minimum altitude [AD-A291666] p 381 N95-28454

CARGO AIRCRAFT

Incorporating biplane wing theory into a large, subsonic, all-cargo transport p 391 N95-26956

CARTESIAN COORDINATES

User documentation of the CTA program [AD-A289508] p 375 N95-26854

CASCADE FLOW

Aerodynamic stability of cascades in turbomachinery [HTN-95-61156] p 405 A95-86255

CASES (CONTAINERS)

Composite intermediate case manufacturing scale-up for advanced engines p 406 N95-28275

CASUALTIES

Reentry analysis for low Earth orbiting spacecraft p 415 A95-85774

CAUCHY PROBLEM

Practical formulation of a positively conservative scheme [HTN-95-51668] p 433 A95-85050

CAVITIES

Hybrid finite element-modal analysis of jet engine inlet scattering [BTN-95-EIX95242673665] p 427 A95-82259
Suppressor of oscillations in airframe cavities [AD-D017265] p 388 N95-26507
Numerical simulation of the SOFIA flow field [NASA-CR-197757] p 436 N95-26589
Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics [NASA-TM-106685] p 416 N95-27434
Measurements of store forces and moments and cavity pressures for a generic store in and near a box cavity at subsonic and transonic speeds [NASA-TM-4611] p 378 N95-28241

CAVITY FLOW

Calculation of three-dimensional (3-D) internal flow by means of the velocity-vorticity formulation on a staggered grid [NASA-TM-110352] p 376 N95-27258
Numerical analysis of intra-cavity and power-stream flow interaction in multiple gas-turbine disk-cavities [NASA-TM-106886] p 407 N95-28344

CAVITY RESONATORS

Hybrid finite element-modal analysis of jet engine inlet scattering [BTN-95-EIX95242673665] p 427 A95-82259

CENTER OF GRAVITY

The analysis of the processing increased weight for pilot production of F-X aircraft [HTN-95-71133] p 385 A95-83494
A quantitative feedback theory FCS design for the subsonic envelope of the VISTA F-16 including configuration variation [AD-A289221] p 409 N95-26958

CENTRAL PROCESSING UNITS

Parallel block implicit integration technique for trajectory parallelism [AD-A288961] p 450 N95-28335

CENTRIFUGAL COMPRESSORS

Pressure and temperature distortion testing of a two-stage centrifugal compressor [BTN-94-EIX95011441250] p 431 A95-84207
Thermo-hydrodynamic solution of floating ring seals for high pressure compressors using the finite-element method [HTN-95-92246] p 433 A95-85290

CERAMIC FIBERS

Ceramic composite combustor cans for expendable turbine engines [AD-A289551] p 407 N95-28646

CERAMIC MATRIX COMPOSITES

Contribution of thermal radiation to the temperature profile of ceramic composite materials [BTN-94-EIX95011441252] p 417 A95-84209
Ceramic composite attachments for transmission of high-torque loads [BTN-94-EIX95011441256] p 417 A95-84213
The potential for CMCs to replace superalloys in engine exhaust ducts [HTN-95-42298] p 418 A95-84992
Ceramic composite combustor cans for expendable turbine engines [AD-A289551] p 407 N95-28646

CERTIFICATION

Bonded composite repair of metallic aircraft components: Overview of Australian activities p 392 N95-27505
Hardware cleanliness methodology and certification p 419 N95-27656
Application of damage tolerance methodology in certification of the Piaggio P-180 Avanti p 399 N95-28480

CHANNEL FLOW

A fixed time performance evaluation of parallel CFD applications [DE94-014240] p 436 N95-26445

CHEMICAL COMPOSITION

Replicator for characterization of cirrus and polar stratospheric cloud particles [NASA-CR-197785] p 445 N95-26669

CHEMICAL EQUILIBRIUM

General solution procedure for flows in local chemical equilibrium [HTN-95-42329] p 404 A95-86158

CHEMICAL PROPERTIES

Photoacoustic chambers for studying solids and gases: Theory and practical examples [IFTR-39/1994] p 412 N95-26837

CHEMICAL REACTIONS

The use of electrochemistry and ellipsometry for identifying and evaluating corrosion on aircraft
[AD-A288536] p 381 N95-27186

CHEMICAL VAPOR INFILTRATION

Ceramic composite combustor cans for expendable turbine engines
[AD-A289551] p 407 N95-28646

CHINESE AIRCRAFT

The analysis of the processing increased weight for pilot production of F-X aircraft
[HTN-95-71133] p 385 A95-83494

CHLORINE OXIDES

Aircraft measurements of CLO and HCL during EASOE 1991/92
[HTN-95-00721] p 444 A95-86291

An overview of millimeter-wave spectroscopic measurements of chlorine monoxide at Thule, Greenland, February-March, 1992: Vertical profiles, diurnal variation, and longer-term trends
[HTN-95-00722] p 444 A95-86292

Airborne measurements during the European Arctic Stratospheric Ozone Experiment: Observation of OClO
[HTN-95-00745] p 445 A95-86315

CIRCUIT BOARDS

CAE for thermal management of aerospace electronic boards using the BETAsoft program
p 438 N95-27354

Life cycle costs of alternatives for F-16 printed circuit board diagnosis equipment
[AD-A288744] p 401 N95-28586

CIRCUIT BREAKERS

Partial discharge testing of high voltage wiring harness for airborne displays
[AD-A289150] p 401 N95-27003

CIRCULAR CONES

The aerodynamic characteristics of cup-like body in supersonic flow
p 427 A95-82407

CIRCULAR CYLINDERS

Observation of traveling waves in the three-dimensional boundary layer along a yawed cylinder
[HTN-95-61064] p 430 A95-83648

CIRRUS CLOUDS

Replicator for characterization of cirrus and polar stratospheric cloud particles
[NASA-CR-197785] p 445 N95-26669

CISLUNAR SPACE

How 'HITEN's' aerobraking experiments were carried out
p 415 A95-82553

CIVIL AVIATION

CFD research, parallel computation and aerodynamic optimization
[NASA-CR-197748] p 373 N95-26649

The high speed civil transport and NASA's High Speed Research (HSR) program
p 390 N95-26945

An integrated GPS/INS/BARO and radar altimeter system for aircraft precision approach landings
[AD-A289280] p 383 N95-26985

A review of Australian and New Zealand investigations on aeronautical fatigue during the period Apr. 1993 - Mar. 1995
[AR-009-202] p 397 N95-27918

Rotorcraft crashworthy airframe and fuel system technology development program
[AD-A289986] p 382 N95-28630

CLEANING

Hardware cleanliness methodology and certification
p 419 N95-27656

CLEANLINESS

Hardware cleanliness methodology and certification
p 419 N95-27656

CLEARANCES

WINCLR: A computer code for heat transfer and clearance calculation in a compressor
[NASA-CR-195436] p 366 N95-26363

CLOUD GLACIATION

Replicator for characterization of cirrus and polar stratospheric cloud particles
[NASA-CR-197785] p 445 N95-26669

CLOUDS (METEOROLOGY)

Effects of a polar stratosphere cloud parameterization on ozone depletion due to stratospheric aircraft in a two-dimensional model
[HTN-95-A1038] p 443 A95-84543

Airborne lidar observation of mountain-wave-induced polar stratospheric clouds during EASOE
[HTN-95-00738] p 444 A95-86308

COATINGS

Mechanism of deposit formation on fuel-wetted hot metal surfaces
[AD-A289847] p 426 N95-28621

COAXIAL FLOW

Near field of a coaxial jet with and without axial excitation
[HTN-95-42332] p 372 A95-86161

Supersonic coaxial jet noise predictions

[NASA-TM-106917] p 451 N95-26801

COAXIAL NOZZLES

The noise reduction potential of dual-stream coaxial rectangular improperly expanded jet flows
[NASA-CR-197820] p 437 N95-26995

COCKPIT SIMULATORS

The photo-realistic AFIT virtual cockpit
[AD-A289376] p 390 N95-26876

COCKPITS

Integrated mission precision attack cockpit technology (IMPACT). Phase 1: Identifying technologies for air-to-ground fighter integration
[AD-A289562] p 389 N95-26684

An analysis of the KC-135 three-person cockpit
[AD-A289540] p 390 N95-26873

The photo-realistic AFIT virtual cockpit
[AD-A289376] p 390 N95-26876

Operator modeling in commercial aviation: Cognitive models, intelligent displays, and pilot's assistants
[NASA-CR-198609] p 401 N95-28203

CODING

Modeling helicopter blade dynamics using a modified Myklestad-Prohl transfer matrix method
[AD-A289891] p 400 N95-28626

COEFFICIENT OF FRICTION

The effects of wall perturbations on thermo-turbulent Couette flow
[HTN-95-92255] p 434 A95-85299

COGNITION

Operator modeling in commercial aviation: Cognitive models, intelligent displays, and pilot's assistants
[NASA-CR-198609] p 401 N95-28203

COLLISIONS

A model for temperature-dependent collisional quenching of OH A(sup 2) Sigma(sup +)
[HTN-95-42308] p 450 A95-85002

COLUMNS (SUPPORTS)

Equivalent beam-column analysis of guyed towers
[BTN-95-EIX95262696644] p 435 A95-85519

COMBAT

A mathematical analysis of the Janus combat simulation weather effects models and sensitivity analysis of sky-to-ground brightness ratio on target detection
[AD-A289629] p 446 N95-26858

COMBUSTIBLE FLOW

Numerical simulation of combustion flow around a flame holder with hydrogen injection
[NAL-TR-1233] p 419 N95-26523

A laboratory scale supersonic combustive flow system
[DE95-006347] p 420 N95-27851

COMBUSTION

Studies on gain performance of a combustion driven CO₂ gas dynamic laser
p 428 A95-82679

Transport phenomena and interfacial kinetics in multiphase combustion systems
[AD-A288297] p 418 N95-26417

Numerical simulation of combustion flow around a flame holder with hydrogen injection
[NAL-TR-1233] p 419 N95-26523

COMBUSTION CHAMBERS

Prediction of pre-combustion shock in scramjet combustors: A new method
p 402 A95-82323

Experiment of rocket-ram annular combustor
p 412 A95-82324

Test results on air turbo ramjet engine for a future space plane
p 402 A95-82327

Studies on plasma jet igniters
p 403 A95-82680

Control requirements for the RB 211 low-emission combustion system
[BTN-94-EIX95011441244] p 416 A95-84201

Flex cycle combustor development and demonstration
[BTN-94-EIX95011441245] p 417 A95-84202

Development of an aeroderivative gas turbine dry low emissions combustion system
[BTN-94-EIX95011441246] p 417 A95-84203

Experiment on a rectangular cross section scramjet combustor. 2: Effects of fuel injector geometry
[NAL-TR-1220] p 405 N95-26600

NASA Lewis Research Center's combustor test facilities and capabilities
[NASA-TM-106903] p 412 N95-27176

Combustion system CFD modeling at GE Aircraft Engines
p 439 N95-27889

Experimental investigation of inlet-combustor isolators for a dual-mode scramjet at a Mach number of 4
[NASA-TP-3502] p 407 N95-28343

Ceramic composite combustor cans for expendable turbine engines
[AD-A289551] p 407 N95-28646

COMBUSTION CHEMISTRY

Transport phenomena and interfacial kinetics in multiphase combustion systems
[AD-A288297] p 418 N95-26417

COMBUSTION EFFICIENCY

Experiment on a rectangular cross section scramjet combustor. 2: Effects of fuel injector geometry
[NAL-TR-1220] p 405 N95-26600

COMBUSTION PHYSICS

Studies on plasma jet igniters
p 403 A95-82680

COMBUSTION TEMPERATURE

NASA Lewis Research Center's combustor test facilities and capabilities
[NASA-TM-106903] p 412 N95-27176

COMFORT

Human factors issues in aircraft cabin design
[SAE PAPER 932527] p 386 A95-84556

COMMAND AND CONTROL

The controller memory guide. Concepts from the field
[AD-A289263] p 383 N95-26978

COMMERCIAL AIRCRAFT

Strategy in the commercial aircraft industry in the United States: A comparison of decisionmaking by McDonnell-Douglas and Boeing aircraft companies from 1977-1983
[AD-A288289] p 366 N95-26409

Radiation safety aspects of commercial high-speed flight transportation
[NASA-TP-3524] p 453 N95-26427

An integrated GPS/INS/BARO and radar altimeter system for aircraft precision approach landings
[AD-A289280] p 383 N95-26985

Study of potential aerodynamic benefits from spanwise blowing at wingtip
[NASA-TP-3515] p 378 N95-28669

COMMUNICATION

Pilot rating scale for aircraft handling qualities
[HTN-95-42269] p 380 A95-84963

COMMUTATION

Dynamically timed electric motor
[NASA-CASE-MFS-28958-1] p 437 N95-26890

COMPARISON

An in situ evaluation of TOPEX/Poseidon altimetric measurements versus measurements made by moorings and inverted echo sounders for sea surface height
[NASA-CR-198621] p 447 N95-27805

COMPLEX SYSTEMS

Digital systems validation. Chapter 20 Artificial Intelligence with applications for aircraft. Handbook, volume 2
[AD-A288492] p 448 N95-26638

The controller memory guide. Concepts from the field
[AD-A289263] p 383 N95-26978

COMPOSITE MATERIALS

A FEAM based methodology for analyzing composite patch repairs of metallic structures
p 394 N95-27511

Rapid repair of large area damage to contoured aircraft structures
p 394 N95-27516

Repair of high temperature composite aircraft structure
p 395 N95-27520

Composite repair of composite structures
p 395 N95-27521

Damage occurrence on composites during testing and fleet service: Repair of Airbus aircraft
p 396 N95-27526

The development of an engineering standard for composite repairs
p 396 N95-27528

Process and control systems for composites manufacturing
p 420 N95-28267

Advanced tow placement of composite fuselage structure
p 420 N95-28271

ACT/ICAPS: Thermoplastic composite activities
p 421 N95-28274

Resin transfer molding of textile preforms for aircraft structural applications
p 421 N95-28276

Analysis techniques for the prediction of springback in formed and bonded composite components
p 421 N95-28289

Utilization of composite materials by the US Army: A look ahead
p 421 N95-28421

Benefits and limitations of composites in carrier-based aircraft
p 422 N95-28422

Development of composite carrythrough bulkhead
p 423 N95-28438

Reliability analysis of composite structures
p 423 N95-28441

Navy composite maintenance and repair experience
p 424 N95-28446

Overview of the ACT program
p 424 N95-28463

Technology integration box beam failure study
p 441 N95-28468

Tension fracture of laminates for transport fuselage. Part 1: Material screening
p 398 N95-28471

Recent progress in NASA Langley textile reinforced composites program
p 425 N95-28475

Impact damage resistance of composite fuselage structure, part 1
p 399 N95-28482

Applications of a damage tolerance analysis methodology in aircraft design and production
p 426 N95-28483

COMPOSITE STRUCTURES

- Shear buckling response of tailored composite plates [HTN-95-51680] p 418 A95-85062
- Torsional actuation with extension-torsion composite coupling and a magnetostrictive actuator [BTN-95-EIX95262694314] p 435 A95-85485
- Non-linear analysis provides new insights into impact damage of composite structures [HTN-95-42368] p 418 A95-86197
- Composite Repair of Military Aircraft Structures [AGARD-CP-550] p 392 N95-27504
- Bonded composite repair of metallic aircraft components: Overview of Australian activities p 392 N95-27505
- Composite repair of metallic airframe: Twenty years of experience p 393 N95-27508
- A FEAM based methodology for analyzing composite patch repairs of metallic structures p 394 N95-27511
- Structural modification and repair of C-130 wing structure using bonded composites p 394 N95-27512
- Field repair materials for naval aircraft p 394 N95-27514
- Rapid repair of large area damage to contoured aircraft structures p 394 N95-27516
- Composite repair of a CF18: Vertical stabilizer leading edge p 395 N95-27517
- Composite repair issues on the CF-18 aircraft p 395 N95-27518
- Repair technology for thermoplastic aircraft structures p 395 N95-27519
- Repair of high temperature composite aircraft structure p 395 N95-27520
- Composite repair of composite structures p 395 N95-27521
- Scar joint technique with cocured and precured patches for composite repair p 396 N95-27524
- Damage occurrence on composites during testing and fleet service: Repair of Airbus aircraft p 396 N95-27526
- Repairs of CFC primary structures p 396 N95-27527
- The development of an engineering standard for composite repairs p 396 N95-27528
- Load transfer in the stiffener-to-skin joints of a pressurized fuselage [NASA-CR-198610] p 439 N95-27865
- Aeroelasticity and structural optimization of composite helicopter rotor blades with swept tips [NASA-CR-4665] p 397 N95-28262
- Static and fatigue testing of full-scale fuselage panels fabricated using a Therm-X(R) process p 420 N95-28270
- Advanced tow placement of composite fuselage structure p 420 N95-28271
- ACT/ICAPS: Thermoplastic composite activities p 421 N95-28274
- Composite intermediate case manufacturing scale-up for advanced engines p 406 N95-28275
- Resin transfer molding of textile preforms for aircraft structural applications p 421 N95-28276
- Analysis of aircraft engine blade subject to ice impact p 407 N95-28277
- Application of fiber-reinforced bismaleimide materials to aircraft nacelle structures p 397 N95-28278
- Composite flight-control actuator development p 410 N95-28281
- Analysis techniques for the prediction of springback in formed and bonded composite components p 421 N95-28289
- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 1 [NASA-CR-198723] p 421 N95-28420
- The effect of material heterogeneity in curved composite beams for use in aircraft structures p 422 N95-28426
- Analysis of composite structures with delaminations under combined bending and compression p 422 N95-28429
- Application of advanced material systems to composite frame elements p 422 N95-28432
- Unique considerations in the design and experimental evaluation of tailored wings with elastically produced chordwise camber p 423 N95-28436
- Effects of floor location on response of composite fuselage frames p 423 N95-28439
- Structural design optimization with survivability dependent constraints application: Primary wing box of a multi-role fighter p 398 N95-28440
- Reliability analysis of composite structures p 423 N95-28441
- Probabilistic design of advanced composite structure p 424 N95-28443
- Navy composite maintenance and repair experience p 424 N95-28446
- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 2 [NASA-CR-198722] p 424 N95-28462

- Overview of the ACT program p 424 N95-28463
- COINS: A composites information database system p 453 N95-28465
- Composite fuselage shell structures research at NASA Langley Research Center p 425 N95-28466
- Structural testing of the technology integration box beam p 441 N95-28467
- Technology integration box beam failure study p 441 N95-28468
- Development of stitched/RTM composite primary structures p 425 N95-28469
- Test and analysis results for composite transport fuselage and wing structures p 398 N95-28470
- Local design optimization for composite transport fuselage crown panels p 398 N95-28473
- Composite fuselage crown panel manufacturing technology p 399 N95-28474
- Recent progress in NASA Langley textile reinforced composites program p 425 N95-28475
- Advanced textile applications for primary aircraft structures p 399 N95-28476
- Characterization and manufacture of braided composites for large commercial aircraft structures p 426 N95-28478
- Application of damage tolerance methodology in certification of the Piaggio P-180 Avanti p 399 N95-28480
- Compressive strength of damaged and repaired composite plates p 442 N95-28484
- Damage tolerance of a geodesically stiffened advanced composite structural concept for aircraft structural applications p 399 N95-28487
- Advanced wing design survivability testing and results p 400 N95-28488
- NASA-ACEE/Boeing 737 graphite-epoxy horizontal stabilizer service p 400 N95-28489
- SMART materials: Surfaces, transforms and interfaces. The commensurate engineering dimension [AD-A289598] p 442 N95-28649
- COMPRESSIBILITY EFFECTS**
- Compressible inviscid vortex flow of a sharp edge delta wing [BTN-95-EIX95262694308] p 370 A95-85479
- COMPRESSIBLE FLOW**
- Direct boundary integral equations method to subsonic flow with circulation past thin airfoils in ground effect [BTN-95-EIX95242673940] p 365 A95-82224
- Predicting stall and post-stall behavior of airfoils at low mach numbers [BTN-95-EIX95262694297] p 365 A95-85468
- Dynamic unstructured method for flows past multiple objects in relative motion [BTN-95-EIX95262694303] p 435 A95-85474
- Compressible Navier-Stokes computations of multi-element airfoil flows using multiblock grids [HTN-95-42327] p 371 A95-86156
- Interferometric investigations of compressible dynamic stall over a transiently pitching airfoil [HTN-95-42338] p 372 A95-86167
- Differencing of density in compressible flow for a pressure-based approach p 373 A95-86178
- A review of the hot-wire technique in 2-D compressible flow [HTN-95-61157] p 373 A95-86256
- TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual [NASA-CR-4349] p 377 N95-28230
- COMPRESSION LOADS**
- Composite repair issues on the CF-18 aircraft p 395 N95-27518
- Analysis of composite structures with delaminations under combined bending and compression p 422 N95-28429
- COMPRESSION TESTS**
- External patch repair of CFRP/honeycomb sandwich p 395 N95-27522
- Test and analysis results for composite transport fuselage and wing structures p 398 N95-28470
- COMPRESSIVE STRENGTH**
- Investigation of static and cyclic bearing failure mechanisms for GR/EP laminates p 422 N95-28427
- Compressive strength of damaged and repaired composite plates p 442 N95-28484
- COMPRESSOR BLADES**
- The effects of surface modification on fretting fatigue in Ti alloy turbine components [HTN-95-61145] p 404 A95-84909
- COMPRESSOR ROTORS**
- Stall precursor study of high frequency data for three high speed, swept compressor rotors [AD-A289379] p 406 N95-26878

- A general theory of two- and three-dimensional rotational flow in subsonic and transonic turbomachines [NASA-CR-4496] p 377 N95-28003
- COMPUTATION**
- CFD research, parallel computation and aerodynamic optimization [NASA-CR-197748] p 373 N95-26649
- A study of workstation computational performance for real-time flight simulation [NASA-TM-109184] p 449 N95-27241
- COMPUTATIONAL FLUID DYNAMICS**
- Direct boundary integral equations method to subsonic flow with circulation past thin airfoils in ground effect [BTN-95-EIX95242673940] p 365 A95-82224
- Rarefied gas numerical wind tunnel: OREX and HOPE p 427 A95-82391
- VSL analysis of hypersonic flows around a reentry vehicle with equilibrium air chemistry p 413 A95-82400
- NAL aerothermodynamic probing and CFD verification mission in OREX experiment p 368 A95-82413
- Numerical simulation of unsteady aerodynamic heating induced by shock reflections p 428 A95-82418
- Instability of three-dimensional boundary layers due to streamline curvature [HTN-95-61070] p 430 A95-83654
- Instability of three-dimensional boundary layers due to streamline curvature [HTN-95-61070] p 430 A95-83654
- Accuracy and efficiency assessments for a weak statement CFD algorithm for high-speed aerodynamics [BTN-94-EIX95011441238] p 370 A95-84195
- Computational/experimental investigation of staged injection into a Mach 2 flow p 432 A95-85028
- [HTN-95-51646] p 432 A95-85028
- Dynamic unstructured method for flows past multiple objects in relative motion [BTN-95-EIX95262694303] p 435 A95-85474
- Computational analysis of buffet alleviation in viscous transonic flow over a porous airfoil [BTN-95-EIX95262694321] p 366 A95-85492
- Using the Liou-Steffen algorithm for the Euler and Navier-Stokes equations [HTN-95-42348] p 373 A95-86177
- Differencing of density in compressible flow for a pressure-based approach [HTN-95-42349] p 373 A95-86178
- Computational fluid dynamics and transonic flow [AD-A288962] p 436 N95-26405
- A non-iterative grid deformation algorithm for computational fluid dynamics for aeroelasticity [AD-A288298] p 436 N95-26418
- A fixed time performance evaluation of parallel CFD applications [DE94-014240] p 436 N95-26445
- Numerical simulation of combustion flow around a flame holder with hydrogen injection [NAL-TR-1233] p 419 N95-26523
- Supersonic transport grid generation, validation, and optimization [NASA-CR-197752] p 448 N95-26648
- CFD research, parallel computation and aerodynamic optimization [NASA-CR-197748] p 373 N95-26649
- Numerical simulation of the flow about the F-18 HARV at high angle of attack [NASA-CR-197755] p 374 N95-26735
- Development of an upwind, finite-volume code with finite-rate chemistry [NASA-CR-197747] p 374 N95-26760
- Computational support of the laminar flow supersonic wind tunnel, CNSF code development, Maglev, and grid generation [NASA-CR-197750] p 411 N95-26775
- Supersonic civil airplane study and design: Performance and sonic boom [NASA-CR-197745] p 390 N95-26813
- A numerical method for unsteady transonic flow about wings with control surfaces [AD-A289631] p 375 N95-26859
- Rarefied gas effects on aerobraking/reentry vehicles with wakes [NASA-CR-196586] p 415 N95-27093
- Application of CFD to the analysis and design of high-speed inlets [NASA-CR-198574] p 438 N95-27240
- NAS Technical Summaries, March 1993 - February 1994 [NASA-RP-1355] p 453 N95-27367
- Optimization of wave rotors for use as gas turbine engine topping cycles [NASA-TM-106951] p 406 N95-27860
- Industry-Wide Workshop on Computational Turbulence Modeling [NASA-CP-10165] p 439 N95-27882

- A summary of computational experience at GE Aircraft Engines for complex turbulent flows in gas turbines p 439 N95-27885
- The applicability of turbulence models to aerodynamic and propulsion flowfields at McDonnell-Douglas Aerospace p 439 N95-27886
- Combustion system CFD modeling at GE Aircraft Engines p 439 N95-27889
- A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines p 439 N95-27980
- TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document [NASA-CR-4348] p 378 N95-28265
- Numerical analysis of intra-cavity and power-stream flow interaction in multiple gas-turbine disk-cavities [NASA-TM-106886] p 407 N95-28344
- Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils [NASA-TP-3496] p 378 N95-28674
- COMPUTATIONAL GRIDS**
- Numerical simulation of unsteady aerodynamic heating induced by shock reflections p 428 A95-82418
- Computational/experimental investigation of staged injection into a Mach 2 flow [HTN-95-51646] p 432 A95-85028
- Practical formulation of a positively conservative scheme [HTN-95-51668] p 433 A95-85050
- Compressible Navier-Stokes computations of multielement airfoil flows using multiblock grids [HTN-95-42327] p 371 A95-86156
- Computational analysis of forebody tangential slot blowing on the high alpha research vehicle [NASA-CR-197754] p 389 N95-26591
- Global flowfield about the V-22 Tiltrotor Aircraft [NASA-CR-198603] p 375 N95-27248
- Calculation of three-dimensional (3-D) internal flow by means of the velocity-vorticity formulation on a staggered grid [NASA-TM-110352] p 376 N95-27258
- TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual [NASA-CR-4349] p 377 N95-28230
- TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document [NASA-CR-4348] p 378 N95-28265
- COMPUTER AIDED DESIGN**
- Aeroelasticity of wing and wing-body configurations on parallel computers [NASA-CR-197756] p 389 N95-26590
- Turbomachinery design and tonal acoustics computations [NASA-CR-197749] p 406 N95-26777
- Supersonic civil airplane study and design: Performance and sonic boom [NASA-CR-197745] p 390 N95-26813
- Naval Aviation System TEAM mapping, charting, and geodesy handbook [AD-A288590] p 446 N95-26841
- Creating an alternative parameter optimization method (APO) p 375 N95-26946
- STEP: A future revision, today [NONP-NASA-VT-95-49121] p 452 N95-27209
- Application of CFD to the analysis and design of high-speed inlets [NASA-CR-198574] p 438 N95-27240
- Advanced flight computer. Special study [NASA-CR-198165] p 449 N95-27246
- CAE for thermal management of aerospace electronic boards using the BETASoft program p 438 N95-27354
- A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines p 439 N95-27980
- Designers' unified cost model p 424 N95-28464
- COINS: A composites information database system p 453 N95-28465
- COMPUTER ASSISTED INSTRUCTION**
- The CBT alternative for aviation training: Is it meeting the need? [SAE PAPER 932596] p 379 A95-84568
- Integrated flight crew transition training for the advanced flight deck aircraft [SAE PAPER 932599] p 380 A95-84571
- New tools for creating instruction and simulations [SAE PAPER 932600] p 380 A95-84572
- The value of simulation for training [AD-A289174] p 411 N95-26556
- COMPUTER DESIGN**
- Advanced flight computer. Special study [NASA-CR-198165] p 449 N95-27246
- COMPUTER GRAPHICS**
- The CBT alternative for aviation training: Is it meeting the need? [SAE PAPER 932596] p 379 A95-84568
- An evaluation of the Software Through Pictures/T Tool (STP/T) for the Software Support Activity (SSA) [AD-A288822] p 447 N95-26348
- EASY-SIM: A visual simulation system software architecture with an Ada 9X application framework [AD-A289325] p 448 N95-26895
- COMPUTER PROGRAMMING**
- STEP: A future revision, today [NONP-NASA-VT-95-49121] p 452 N95-27209
- Control system design for the MOD-5A 7.3 mW wind turbine generator p 440 N95-27985
- Software process improvement in the NASA software engineering laboratory [AD-A289912] p 450 N95-28627
- COMPUTER PROGRAMS**
- A non-iterative grid deformation algorithm for computational fluid dynamics for aeroelasticity [AD-A288298] p 436 N95-26418
- Design and synthesis of a real-time controller for an unmanned air vehicle [AD-A289134] p 408 N95-26555
- Comparison of fixed wing aircraft algorithms for JANUS [AD-A288503] p 389 N95-26652
- Development of an upwind, finite-volume code with finite-rate chemistry [NASA-CR-197747] p 374 N95-26760
- STEP: A future revision, today [NONP-NASA-VT-95-49121] p 452 N95-27209
- Application of CFD to the analysis and design of high-speed inlets [NASA-CR-198574] p 438 N95-27240
- Global flowfield about the V-22 Tiltrotor Aircraft [NASA-CR-198603] p 375 N95-27248
- CAE for thermal management of aerospace electronic boards using the BETASoft program p 438 N95-27354
- Flight Mechanics/Estimation Theory Symposium 1995 [NASA-CP-3299] p 416 N95-27763
- A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines p 439 N95-27980
- Aeroelastic stability of wind turbine blade/aileron systems p 377 N95-27981
- Calculation of design load for the MOD-5A 7.3 mW wind turbine system p 440 N95-27982
- Control system design for the MOD-5A 7.3 mW wind turbine generator p 440 N95-27985
- Operator modeling in commercial aviation: Cognitive models, intelligent displays, and pilot's assistants [NASA-CR-198609] p 401 N95-28203
- TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual [NASA-CR-4349] p 377 N95-28230
- TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document [NASA-CR-4348] p 378 N95-28265
- Probabilistic evaluation of fuselage-type composite structures p 398 N95-28444
- Software process improvement in the NASA software engineering laboratory [AD-A289912] p 450 N95-28627
- COMPUTER SYSTEMS DESIGN**
- Advanced flight computer. Special study [NASA-CR-198165] p 449 N95-27246
- Design of a real-time wind turbine simulator using a custom parallel architecture p 449 N95-27979
- COMPUTER SYSTEMS PERFORMANCE**
- Digital systems validation. Chapter 20 Artificial Intelligence with applications for aircraft. Handbook, volume 2 [AD-A288492] p 448 N95-26638
- Control system design for the MOD-5A 7.3 mW wind turbine generator p 440 N95-27985
- COMPUTER VISION**
- EASY-SIM: A visual simulation system software architecture with an Ada 9X application framework [AD-A289325] p 448 N95-26895
- COMPUTERIZED SIMULATION**
- GETRAN: A generic, modularly structured computer code for simulation of dynamic behavior of aero- and power generation gas turbine engines [BTN-94-EIX95011441241] p 431 A95-84198
- Effects of a polar stratosphere cloud parameterization on ozone depletion due to stratospheric aircraft in a two-dimensional model [HTN-95-A1038] p 443 A95-84543
- General solution procedure for flows in local chemical equilibrium [HTN-95-42329] p 404 A95-86158
- The 1994 updated National Airspace System performance assessment for year 2005 [AD-A288652] p 380 N95-26485
- Numerical simulation of combustion flow around a flame holder with hydrogen injection [NAL-TR-1233] p 419 N95-26523
- The value of simulation for training [AD-A289174] p 411 N95-26556
- Comparison of fixed wing aircraft algorithms for JANUS [AD-A288503] p 389 N95-26652
- Numerical simulation of the flow about the F-18 HARV at high angle of attack [NASA-CR-197755] p 374 N95-26735
- A numerical model to predict the fate of jettisoned aviation fuel [AD-A289336] p 419 N95-26842
- A mathematical analysis of the Janus combat simulation weather effects models and sensitivity analysis of sky-to-ground brightness ratio on target detection [AD-A289629] p 446 N95-26858
- The photo-realistic AFIT virtual cockpit [AD-A289376] p 390 N95-26876
- EASY-SIM: A visual simulation system software architecture with an Ada 9X application framework [AD-A289325] p 448 N95-26895
- Analysis and simulation of narrowband GPS jamming using digital excision temporal filtering [AD-A289328] p 383 N95-26898
- Aircraft nosewheel steering simulation p 412 N95-26944
- Implementation and demonstration of a multiple model adaptive estimation failure detection system for the F-16 [AD-A289301] p 391 N95-27042
- CAE for thermal management of aerospace electronic boards using the BETASoft program p 438 N95-27354
- NAS Technical Summaries, March 1993 - February 1994 [NASA-RP-1355] p 453 N95-27367
- Precision landing system mathematical modeling study report for Andrews Air Force Base, runway 19L, Camp Springs, MD [AD-A289015] p 384 N95-27903
- A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines p 439 N95-27980
- Aeroelastic stability of wind turbine blade/aileron systems p 377 N95-27981
- A hybrid vehicle evaluation code and its application to vehicle design. Revision 1 [DE95-008053] p 441 N95-28029
- A hybrid vehicle evaluation code and its application to vehicle design, revision 2 [DE95-008060] p 441 N95-28139
- Analysis of aircraft engine blade subject to ice impact p 407 N95-28277
- Unmanned aerial vehicles, 1994 master plan [AD-A291628] p 398 N95-28411
- Numerical simulation of crack growth in pressurized fuselages [PB95-192415] p 400 N95-28636
- CONCAVITY**
- Multiple instabilities of three-dimensional boundary layers along a concave wall [HTN-95-71126] p 429 A95-83487
- CONCENTRATION (COMPOSITION)**
- Evolution of the concentrations of trace species in an aircraft plume: Trajectory study [HTN-95-A1044] p 443 A95-84549
- CONCURRENT ENGINEERING**
- STEP: A future revision, today [NONP-NASA-VT-95-49121] p 452 N95-27209
- CONDUCTIVE HEAT TRANSFER**
- CAE for thermal management of aerospace electronic boards using the BETASoft program p 438 N95-27354
- CONDUCTIVITY**
- The effect of aviation fuels containing low amounts of static dissipater additive on electrostatic charge generation [AD-A280075] p 420 N95-28152
- CONES**
- Transition correlations in three-dimensional boundary layers [HTN-95-51648] p 432 A95-85030

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- Composite Repair of Military Aircraft Structures
[AGARD-CP-550] p 392 N95-27504
- Flight Mechanics/Estimation Theory Symposium 1995
[NASA-CP-3299] p 416 N95-27763
- Industry-Wide Workshop on Computational Turbulence Modeling
[NASA-CP-10165] p 439 N95-27882
- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 3
[NASA-CR-198718] p 420 N95-28266
- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 1
[NASA-CR-198723] p 421 N95-28420
- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 2
[NASA-CR-198722] p 424 N95-28462
- Proceedings of the AIAA/FAA joint symposium on general aviation systems
[AD-A289830] p 368 N95-28610
- CONFIGURATION MANAGEMENT**
Report to Congressional Committees. Comanche Helicopter: Testing needs to be completed prior to production decisions
[GAO/NSIAD-95-112] p 397 N95-27910
- CONGRESSIONAL REPORTS**
Report to Congressional Committees. Comanche Helicopter: Testing needs to be completed prior to production decisions
[GAO/NSIAD-95-112] p 397 N95-27910
- CONSTITUTIVE EQUATIONS**
Non-linear viscoelastic-plastic constitutive relations for an aeronautical PMMA
[HTN-95-71132] p 385 A95-83493
- CONTAMINANTS**
Aircraft gas turbine emissions challenge
[BTN-94-EIX95011441239] p 403 A95-84196
- Nitrogen oxide emissions characteristics of augmented turbofan engines
[BTN-94-EIX95011441240] p 403 A95-84197
- CONTAMINATION**
Community relations plan: Galena Airport and Camp ion Air Force Station, Alaska
[AD-A286722] p 446 N95-27234
- Hardware cleanliness methodology and certification
p 419 N95-27656
- CONTROL EQUIPMENT**
Simulation model of the integrated flight/propulsion control system, displays, and propulsion system for ASTOVL lift-fan aircraft
[NASA-TM-108866] p 405 N95-26412
- Plate manipulators
[AD-A289601] p 374 N95-26719
- CONTROL SIMULATION**
Development of a nonlinear simulation for the McDonnell Douglas F-15 Eagle with a longitudinal TECS control-law
[AD-A288610] p 388 N95-26481
- CONTROL STABILITY**
Use of blade pitch control to provide power train damping for the Mod-2, 2.5-mW wind turbine p 440 N95-27986
- CONTROL SURFACES**
Plate manipulators
[AD-A289601] p 374 N95-26719
- A numerical method for unsteady transonic flow about wings with control surfaces
[AD-A289631] p 375 N95-26859
- Implementation and demonstration of a multiple model adaptive estimation failure detection system for the F-16
[AD-A289301] p 391 N95-27042
- CONTROL SYSTEMS DESIGN**
Nonlinear observer and its application in flight control p 447 A95-82449
- Robust longitudinal axis flight control for an aircraft with thrust vectoring
[BTN-95-EIX95122538875] p 408 A95-83000
- Control requirements for the RB 211 low-emission combustion system
[BTN-94-EIX95011441244] p 416 A95-84201
- Scheduling of local nonlinear control laws by exogenous signals - an application to flight control
[BTN-95-EIX95262694059] p 447 A95-85675
- Demonstration study of hierarchical control of fluid-dynamic phenomena
[AD-A289341] p 437 N95-26751
- A gain scheduling optimization method using genetic algorithms
[AD-A289306] p 448 N95-26920

- Prevention and control of inlet unstart using an SR-71 simulation p 367 N95-26948
- Collected papers on wind turbine technology
[NASA-CR-195432] p 447 N95-27970
- Control system design for the MOD-5A 7.3 mW wind turbine generator p 440 N95-27985
- Use of blade pitch control to provide power train damping for the Mod-2, 2.5-mW wind turbine p 440 N95-27986
- Variable speed generator application on the MOD-5A 7.3 mW wind turbine generator p 440 N95-27989
- Development of a TECS control-law for the lateral directional axis of the McDonnell Douglas F-15 Eagle
[AD-A289771] p 410 N95-28598
- CONTROL THEORY**
Nonlinear observer and its application in flight control p 447 A95-82449
- Robust longitudinal axis flight control for an aircraft with thrust vectoring
[BTN-95-EIX95122538875] p 408 A95-83000
- Scheduling of local nonlinear control laws by exogenous signals - an application to flight control
[BTN-95-EIX95262694059] p 447 A95-85675
- Development of a nonlinear simulation for the McDonnell Douglas F-15 Eagle with a longitudinal TECS control-law
[AD-A288610] p 388 N95-26481
- A comparison of the Neal-Smith and omega Tau function, zeta function and tau function flying qualities criteria
[AD-A289503] p 390 N95-26844
- Advanced formation flight control
[AD-A289271] p 409 N95-26981
- Development of a TECS control-law for the lateral directional axis of the McDonnell Douglas F-15 Eagle
[AD-A289771] p 410 N95-28598
- CONTROLLABILITY**
Pilot rating scale for aircraft handling qualities
[HTN-95-42269] p 380 A95-84963
- An investigation of the effects of pitch-roll (de)coupling on helicopter handling qualities
[NASA-TM-110349] p 409 N95-26773
- A comparison of the Neal-Smith and omega Tau function, zeta function and tau function flying qualities criteria
[AD-A289503] p 390 N95-26844
- Test operations procedure (TOP) 7-3-534 airworthiness testing of fixed wing aircraft: Asymmetric power testing
[AD-A289458] p 391 N95-26994
- CONTROLLERS**
Design and synthesis of a real-time controller for an unmanned air vehicle
[AD-A289134] p 408 N95-26555
- Electro-hydrostatic actuator controller design using quantitative feedback theory
[AD-A289220] p 409 N95-26957
- Survey and implementation of commercial manual controllers for a generic telerobotics architecture
[AD-A289215] p 449 N95-26990
- Flight control design using mixed H2/micron optimization
[AD-A289288] p 410 N95-27036
- A hybrid vehicle evaluation code and its application to vehicle design. Revision 1
[DE95-008053] p 441 N95-28029
- CONVECTIVE FLOW**
Nonreflective boundary conditions for high-order methods
[HTN-95-42328] p 371 A95-86157
- CONVECTIVE HEAT TRANSFER**
Study of heat transfer rates during quenching of a hot tube under microgravity p 428 A95-82641
- Experimental investigation of flow-boiling heat transfer under microgravity p 428 A95-82642
- Free convection past a uniform flux surface inclined at a small angle to the horizontal p 430 A95-84029
- Constant flux, turbulent convection data using infrared imaging
[HTN-95-20731] p 435 A95-86621
- CAE for thermal management of aerospace electronic boards using the BETAsoft program p 438 N95-27354
- COOLING**
Experiment and analysis on heat transfer of a scramjet leading edge model p 403 A95-82420
- Airborne lidar observation of mountain-wave-induced polar stratospheric clouds during EASOE
[HTN-95-00738] p 444 A95-86308
- CAE for thermal management of aerospace electronic boards using the BETAsoft program p 438 N95-27354
- COOLING SYSTEMS**
Hypersonic thermal protection with mass injection at angle of attack p 414 A95-82414
- Study on the turbine vane and blade for a 1500 C class industrial gas turbine
[BTN-94-EIX95011441254] p 431 A95-84211

COORDINATE TRANSFORMATIONS

- User documentation of the CTA program
[AD-A289508] p 375 N95-26854
- COPPER**
Permanent magnet electron cyclotron resonance plasma source with remote window
[BTN-95-EIX95242674338] p 450 A95-82176
- CORRELATION**
Transition correlations in three-dimensional boundary layers
[HTN-95-51648] p 432 A95-85030
- CORROSION**
The use of electrochemistry and ellipsometry for identifying and evaluating corrosion on aircraft
[AD-A288536] p 381 N95-27186
- CORROSION PREVENTION**
Characterization of corrosion and development of a breadboard of a D sight aircraft inspection system, phase 1
[AD-A288347] p 380 N95-26527
- COST ANALYSIS**
Development of repair processes and sources for C/KC-135 aircraft windows/windshields
[AD-A288348] p 367 N95-26629
- An analysis of the KC-135 three-person cockpit
[AD-A289540] p 390 N95-26873
- C-130 Advanced Technology Center wing box conceptual design/cost study p 423 N95-28437
- Designers' unified cost model p 424 N95-28464
- COST EFFECTIVENESS**
Assessment of cost and training effectiveness for a candidate training system using the Comparison-Based Prediction model
[SAE PAPER 932598] p 379 A95-84570
- Integrated flight crew transition training for the advanced flight deck aircraft
[SAE PAPER 932599] p 380 A95-84571
- The potential for CMCs to replace superalloys in engine exhaust ducts
[HTN-95-42298] p 418 A95-84992
- Report to Congressional Committees. Comanche Helicopter: Testing needs to be completed prior to production decisions
[GAO/NSIAD-95-112] p 397 N95-27910
- COST ESTIMATES**
Report to Congressional Committees. Comanche Helicopter: Testing needs to be completed prior to production decisions
[GAO/NSIAD-95-112] p 397 N95-27910
- COST REDUCTION**
Cuts endanger airborne research --- NASA Ames Research Center Reorganization
[HTN-95-20602] p 443 A95-84783
- C-130 Advanced Technology Center wing box conceptual design/cost study p 423 N95-28437
- Composite fuselage crown panel manufacturing technology p 399 N95-28474
- COSTS**
Optimal trajectories for hypersonic launch vehicles
[HTN-95-61120] p 415 A95-84884
- COUETTE FLOW**
The effects of wall perturbations on thermo-turbulent Couette flow
[HTN-95-92255] p 434 A95-85299
- COUPLING**
An investigation of the effects of pitch-roll (de)coupling on helicopter handling qualities
[NASA-TM-110349] p 409 N95-26773
- CRACK PROPAGATION**
Flight simulation fatigue crack growth testing of aluminum alloys
[HTN-95-00652] p 418 A95-84731
- Adhesively bonded composite patch repair of cracked aluminum alloy structures p 393 N95-27507
- Prediction of fatigue crack growth under constant amplitude and random loading using specimens with multiple cracks
[AD-A291614] p 397 N95-28409
- Numerical simulation of crack growth in pressurized fuselages
[PB95-192415] p 400 N95-28636
- CRACKING (FRACTURING)**
Flight simulation fatigue crack growth testing of aluminum alloys
[HTN-95-00652] p 418 A95-84731
- Status and prospects for aluminum-lithium alloys in aircraft structures p 387 A95-85893
- Fatigue of aircraft materials and structures
p 387 A95-85894
- Fibre-Metal laminates p 387 A95-85895
- Verification of the damage tolerance of a fighter aircraft p 388 A95-85897
- Damage tolerance capability p 388 A95-85898
- Evaluation of patch effectiveness in repairing aircraft components p 394 N95-27513

Numerical simulation of crack growth in pressurized fuselages
[PB95-192415] p 400 N95-28636

CRACKS
Bonded composite repair of metallic aircraft components: Overview of Australian activities
p 392 N95-27505
Design and structural validation of CF116 upper wing skin boron doubler p 393 N95-27510
Evaluation of patch effectiveness in repairing aircraft components p 394 N95-27513
Prediction of fatigue crack growth under constant amplitude and random loading using specimens with multiple cracks
[AD-A291614] p 397 N95-28409

CRASHES
Rotorcraft crashworthy airframe and fuel system technology development program
[AD-A289986] p 382 N95-28630

CRASHWORTHINESS
Rotorcraft crashworthy airframe and fuel system technology development program
[AD-A289986] p 382 N95-28630

CREEP PROPERTIES
Probabilistic material strength degradation model for Inconel 718 components subjected to high temperature, high-cycle and low-cycle mechanical fatigue, creep and thermal fatigue effects
[NASA-CR-197832] p 419 N95-27167
Sscar repairs to graphite/epoxy components
p 396 N95-27523

CRITICAL LOADING
Fundamental concepts in the suppression of delamination buckling by stitching p 426 N95-28486

CROSS FLOW
Observation of traveling waves in the three-dimensional boundary layer along a yawed cylinder
[HTN-95-61064] p 430 A95-83648
Crossflow topology of vortical flows
[HTN-95-51664] p 432 A95-85046

CURING
External patch repair of CFRP/honeycomb sandwich
p 395 N95-27522

CURVATURE
Instability of three-dimensional boundary layers due to streamline curvature
[HTN-95-61070] p 430 A95-83654

CURVED BEAMS
The effect of material heterogeneity in curved composite beams for use in aircraft structures p 422 N95-28426

CURVED PANELS
Rapid repair of large area damage to contoured aircraft structures p 394 N95-27516
Static and fatigue testing of full-scale fuselage panels fabricated using a Therm-X(R) process
p 420 N95-28270

CYCLIC LOADS
Non-linear viscoelastic-plastic constitutive relations for an aeronautical PMMA
[HTN-95-71132] p 385 A95-83493
Probabilistic material strength degradation model for Inconel 718 components subjected to high temperature, high-cycle and low-cycle mechanical fatigue, creep and thermal fatigue effects
[NASA-CR-197832] p 419 N95-27167
Preliminary analysis of dynamic stall effects on a 91-meter wind turbine rotor p 376 N95-27975
Calculation of design load for the MOD-5A 7.3 mW wind turbine system p 440 N95-27982
Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system
p 440 N95-27983
Investigation of static and cyclic bearing failure mechanisms for GR/EP laminates p 422 N95-28427

CYCLOTRON RADIATION
Permanent magnet electron cyclotron resonance plasma source with remote window
[BTN-95-EIX95242674338] p 450 A95-82176

CYCLOTRON RESONANCE
Permanent magnet electron cyclotron resonance plasma source with remote window
[BTN-95-EIX95242674338] p 450 A95-82176

CYLINDERS
Numerical investigation of cylinder wake flow with a rear stagnation jet
[HTN-95-51669] p 433 A95-85051

CYLINDRICAL BODIES
Wind-tunnel tests of an inclined cylinder having helical grooves
[BTN-95-EIX95262694306] p 411 A95-85477
Effects of three-dimensional imposed 3-D disturbances on bluff-body near wake flows
[AD-A289553] p 374 N95-26757

CYLINDRICAL SHELLS

Load transfer in the stiffener-to-skin joints of a pressurized fuselage
[NASA-CR-198610] p 439 N95-27865

D

DAMAGE

Sscar repairs to graphite/epoxy components
p 396 N95-27523
Damage occurrence on composites during testing and fleet service: Repair of Airbus aircraft
p 396 N95-27526
Comparison of resin film infusion, resin transfer molding, and consolidation of textile preforms for primary aircraft structure p 425 N95-28477
Application of damage tolerance methodology in certification of the Piaggio P-180 Avanti
p 399 N95-28480

DAMAGE ASSESSMENT

Flight simulation fatigue crack growth testing of aluminum alloys
[HTN-95-00652] p 418 A95-84731
Status and prospects for aluminium-lithium alloys in aircraft structures p 387 A95-85893
Elements of structural integrity assurance
p 387 A95-85896
Verification of the damage tolerance of a fighter aircraft p 388 A95-85897
Damage tolerance capability p 388 A95-85898
Navy composite maintenance and repair experience
p 424 N95-28446
Compressive strength of damaged and repaired composite plates p 442 N95-28484
SMART materials: Surfaces, transforms and interfaces. The commensurate engineering dimension
[AD-A289598] p 442 N95-28649

DAMPING

Use of blade pitch control to provide power train damping for the Mod-2, 2.5-mW wind turbine p 440 N95-27986

DATA ACQUISITION

Weather And Radar Processor (WARP) Test and Evaluation Master Plan (TEMP)
[AD-A288280] p 445 N95-26453

DATA BASES

AIAA Techfest 20 Proceedings
[NIAA-94-1] p 367 N95-26941
Horizontal axis wind turbine post stall airfoil characteristics synthesisization p 376 N95-27974
Enplanement and all cargo activity
[AD-A280074] p 412 N95-28151
Overview of the ACT program p 424 N95-28463
COINS: A composites information database system
p 453 N95-28465
Proceedings of the AIAA/FAA joint symposium on general aviation systems
[AD-A289830] p 368 N95-28610

DATA CONVERSION ROUTINES

User documentation of the CTA program
[AD-A289508] p 375 N95-26854

DATA PROCESSING

Data processing and mapping in airborne radiometric surveys
[HTN-95-51587] p 442 A95-83591
Weather And Radar Processor (WARP) Test and Evaluation Master Plan (TEMP)
[AD-A288280] p 445 N95-26453
Stall precursor study of high frequency data for three high speed, swept compressor rotors
[AD-A289379] p 406 N95-26878
STEP: A futurevision, today
[NONP-NASA-VT-95-49121] p 452 N95-27209

DATA RECORDERS

Micro-time stress measurement device development
[AD-A289511] p 448 N95-26845

DATA TRANSFER (COMPUTERS)

STEP: A futurevision, today
[NONP-NASA-VT-95-49121] p 452 N95-27209

DEBONDING (MATERIALS)

Evaluation of patch effectiveness in repairing aircraft components p 394 N95-27513
Composite repair issues on the CF-18 aircraft
p 395 N95-27518

DECISION MAKING

Strategy in the commercial aircraft industry in the United States: A comparison of decisionmaking by McDonnell-Douglas and Boeing aircraft companies from 1977-1983
[AD-A288289] p 366 N95-26409
Community relations plan: Galena Airport and Camp ion Air Force Station, Alaska
[AD-A286722] p 446 N95-27234

DECISION THEORY

Classification of ultra high range resolution radar using decision boundary analysis
[AD-A289378] p 437 N95-26877

DECOUPLING

Nonlinear decoupling control study for aircraft maneuvering flight
[HTN-95-71130] p 408 A95-83491
An investigation of the effects of pitch-roll (de)coupling on helicopter handling qualities
[NASA-TM-110349] p 409 N95-26773

DEFECTS

Verification of the damage tolerance of a fighter aircraft p 388 A95-85897
Damage tolerance capability p 388 A95-85898

DEFENSE INDUSTRY

Surviving the peace. Lessons learned from the aircraft industry in the 1920s and 1930s
[AD-A288284] p 366 N95-26455

DEFENSE PROGRAM

An integrated GPS/INS/BARO and radar altimeter system for aircraft precision approach landings
[AD-A289280] p 383 N95-26985
Unmanned aerial vehicles, 1994 master plan
[AD-A291628] p 398 N95-28411

DEFLECTION

A non-iterative grid deformation algorithm for computational fluid dynamics for aeroelasticity
[AD-A288298] p 436 N95-26418

DEFORMATION

A non-iterative grid deformation algorithm for computational fluid dynamics for aeroelasticity
[AD-A288298] p 436 N95-26418

DEGRADATION

Life evaluation of a low power arcjet thruster
p 403 A95-82337
Probabilistic material strength degradation model for Inconel 718 components subjected to high temperature, high-cycle and low-cycle mechanical fatigue, creep and thermal fatigue effects
[NASA-CR-197832] p 419 N95-27167

DEGREES OF FREEDOM

Equivalent beam-column analysis of guyed towers
[BTN-95-EIX95262696644] p 435 A95-85519
Aeroelastic stability of wind turbine blade/aileron systems p 377 N95-27981

DEICING

Replicator for characterization of cirrus and polar stratospheric cloud particles
[NASA-CR-197785] p 445 N95-26669

DELAMINATING

Composite repair issues on the CF-18 aircraft
p 395 N95-27518
Repair technology for thermoplastic aircraft structures
p 395 N95-27519
Through-the Thickness(R) braided composites for aircraft applications p 421 N95-28273
Analysis of composite structures with delaminations under combined bending and compression
p 422 N95-28429
Fundamental concepts in the suppression of delamination buckling by stitching p 426 N95-28486

DELTA WINGS

Measurements of vortex pair interaction with a clean or contaminated free surface
[BTN-94-EIX95011441063] p 429 A95-82798
Crossflow topology of vortical flows
[HTN-95-51664] p 432 A95-85046
Compressible inviscid vortex flow of a sharp edge delta wing
[BTN-95-EIX95262694308] p 370 A95-85479

DENSIFICATION

Ceramic composite combustor cans for expendable turbine engines
[AD-A289551] p 407 N95-28646

DENSITY (MASS/VOLUME)

Differencing of density in compressible flow for a pressure-based approach
[HTN-95-42349] p 373 A95-86178

DENSITY DISTRIBUTION

Practical formulation of a positively conservative scheme
[HTN-95-51668] p 433 A95-85050

DEPOSITS

Mechanism of deposit formation on fuel-wetted hot metal surfaces
[AD-A289847] p 426 N95-28621

DESIGN ANALYSIS

An inverse design method of transonic airfoil and wing
[HTN-95-71128] p 385 A95-83489
Mobile domes for TACTIC telescope
p 453 A95-86113
Supersonic transport grid generation, validation, and optimization
[NASA-CR-197752] p 448 N95-26648

- CFD research, parallel computation and aerodynamic optimization
[NASA-CR-197748] p 373 N95-26649
- Design and testing of low sonic boom configurations and an oblique all-wing supersonic transport
[NASA-CR-197744] p 389 N95-26651
- Preliminary design problems and solutions for a supersonic oblique all-wing transport aircraft
p 390 N95-26942
- An exploratory application of neural networks for airfoil design
p 448 N95-26943
- A verification procedure for MSC/NASTRAN Finite Element Models
[NASA-CR-4675] p 392 N95-27371
- Wind-tunnel test of the S814 thick root airfoil
[DE95-000268] p 376 N95-27541
- Vibration analysis of a split path gearbox
[NASA-TM-106875] p 438 N95-27855
- Use of blade pitch control to provide power train damping for the Mod-2, 2.5-mW wind turbine p 440 N95-27986
- Variable speed generator application on the MOD-5A 7.3 mW wind turbine generator p 440 N95-27989
- Advanced interactive display formats for terminal area traffic control
[NASA-CR-198576] p 384 N95-28188
- Performance study for inlet installations
[NASA-CR-189714] p 406 N95-28227
- Unique considerations in the design and experimental evaluation of tailored wings with elastically produced chordwise camber p 423 N95-28436
- C-130 Advanced Technology Center wing box conceptual design/cost study p 423 N95-28437
- Probabilistic design of advanced composite structure p 424 N95-28443
- Nonlinear dynamics and aeroelasticity of rotorcraft in forward flight
[AD-A291714] p 400 N95-28504
- DIAGNOSIS**
Condition monitoring and diagnostics
[HTN-95-92312] p 387 A95-85356
- DIAMETERS**
Permanent magnet electron cyclotron resonance plasma source with remote window
[BTN-95-EIX95242674338] p 450 A95-82176
- DIFFUSION**
Forming and bonding techniques for high-strength aluminum alloys
[HTN-95-20605] p 418 A95-84786
- DIGITAL COMMAND SYSTEMS**
Advanced flight computer. Special study
[NASA-CR-198165] p 449 N95-27246
- DIGITAL ELECTRONICS**
Advanced flight computer. Special study
[NASA-CR-198165] p 449 N95-27246
- DIGITAL FILTERS**
Analysis and simulation of narrowband GPS jamming using digital excision temporal filtering
[AD-A289328] p 383 N95-26898
- DIGITAL SIMULATION**
Design of a real-time wind turbine simulator using a custom parallel architecture p 449 N95-27979
- Parallel block implicit integration technique for trajectory parallelism
[AD-A288961] p 450 N95-28335
- DIGITAL SYSTEMS**
Digital systems validation. Chapter 20 Artificial Intelligence with applications for aircraft. Handbook, volume 2
[AD-A288492] p 448 N95-26638
- DIRECT CURRENT**
Dynamically timed electric motor
[NASA-CASE-MFS-28958-1] p 437 N95-26890
- DIRECTIONAL STABILITY**
An easy way to analyze longitudinal and lateral-directional trim problems with AEO or OEI
p 409 N95-26949
- DISCONNECT DEVICES**
Partial discharge testing of high voltage wiring harness for airborne displays
[AD-A289150] p 401 N95-27003
- DISPERSING**
A numerical model to predict the fate of jettisoned aviation fuel
[AD-A289336] p 419 N95-26842
- DISPERSIONS**
Active open-loop control of particle dispersion in round jets
[HTN-95-42334] p 372 A95-86163
- DISPLAY DEVICES**
Part-task simulator evaluations of advanced terrain displays
[SAE PAPER 932570] p 401 A95-84567
- Advanced interactive display formats for terminal area traffic control
[NASA-CR-198576] p 384 N95-28188
- Operator modeling in commercial aviation: Cognitive models, intelligent displays, and pilot's assistants
[NASA-CR-198609] p 401 N95-28203
- DISSIPATION**
The effect of aviation fuels containing low amounts of static dissipater additive on electrostatic charge generation
[AD-A280075] p 420 N95-28152
- DISTANCE MEASURING EQUIPMENT**
Precision landing system mathematical modeling study report for Andrews Air Force Base, runway 19L, Camp Springs, MD
[AD-A289015] p 384 N95-27903
- DISTORTION**
Pressure and temperature distortion testing of a two-stage centrifugal compressor
[BTN-94-EIX95011441250] p 431 A95-84207
- DIURNAL VARIATIONS**
An overview of millimeter-wave spectroscopic measurements of chlorine monoxide at Thule, Greenland, February-March, 1992: Vertical profiles, diurnal variation, and longer-term trends
[HTN-95-00722] p 444 A95-86292
- DOUGLAS AIRCRAFT**
Evaluation of all-electric secondary power for transport aircraft
[NASA-CR-189077] p 441 N95-27999
- DRAG REDUCTION**
Flow past a symmetric wedge with forward splitter plate p 427 A95-82406
- Plate manipulators
[AD-A289601] p 374 N95-26719
- DUCTED FLOW**
Screech tones from free and ducted supersonic jets
[HTN-95-51647] p 432 A95-85029
- DURABILITY**
Elements of structural integrity assurance p 387 A95-85896
- Development of stitched/RTM composite primary structures p 425 N95-28469
- DUST**
Effects of dust from storage heaters on ignition in scramjets
[NAL-TR-1234] p 405 N95-26706
- DYNAMIC CHARACTERISTICS**
GETRAN: A generic, modularly structured computer code for simulation of dynamic behavior of aero- and power generation gas turbine engines
[BTN-94-EIX95011441241] p 431 A95-84198
- DYNAMIC CONTROL**
A review of falconry as a bird control technique with recommendations for use at the Shuttle Landing Facility, John F. Kennedy Space Center, Florida, USA
[NASA-TM-110142] p 381 N95-27859
- DYNAMIC LOADS**
Ceramic composite attachments for transmission of high-torque loads
[BTN-94-EIX95011441256] p 417 A95-84213
- Artificial neural networks for predicting nonlinear dynamic helicopter loads
[HTN-95-51678] p 404 A95-85060
- A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines
p 439 N95-27980
- DYNAMIC MODELS**
Extension to the dynamic modeling of the large angle magnetic suspension test fixture
[NASA-CR-197801] p 411 N95-26768
- DYNAMIC PRESSURE**
Wind tunnel experiments on wake flow field behind a reentry capsule from a viewpoint of parachute deployment at supersonic speeds
[ISAS-655] p 374 N95-26740
- Comparative wind tunnel tests of NACA 23024 airfoils with several aileron and spoiler configurations
p 376 N95-27976
- DYNAMIC RESPONSE**
Subharmonic and quasi-periodic motions of an eccentric squeeze film damper-mounted rigid rotor
[BTN-94-EIX95011440601] p 429 A95-82982
- Observed acoustic and aeroelastic spectral responses of a MOD-2 turbine blade to turbulence excitation
p 451 N95-27991
- Aeroelasticity and structural optimization of composite helicopter rotor blades with swept tips
[NASA-CR-4665] p 397 N95-28262
- Impact damage resistance of composite fuselage structure, part 1 p 399 N95-28482
- DYNAMIC STRUCTURAL ANALYSIS**
Ceramic composite attachments for transmission of high-torque loads
[BTN-94-EIX95011441256] p 417 A95-84213
- Vibration analysis of a split path gearbox
[NASA-TM-106875] p 438 N95-27855
- Collected papers on wind turbine technology
[NASA-CR-195432] p 447 N95-27970
- A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines
p 439 N95-27980
- Structural design optimization with survivability dependent constraints application: Primary wing box of a multi-role fighter p 398 N95-28440
- Reliability analysis of composite structures
p 423 N95-28441
- Technology integration box beam failure study
p 441 N95-28468
- DYNAMIC TESTS**
Experimental investigation of static and dynamic ground effect on HOPE ALFLEX vehicle
[NAL-TR-1236] p 388 N95-26525
- E**
- EARTH RESOURCES PROGRAM**
Cuts endanger airborne research --- NASA Ames Research Center Reorganization
[HTN-95-20602] p 443 A95-84783
- EARTH SCIENCES**
Cuts endanger airborne research --- NASA Ames Research Center Reorganization
[HTN-95-20602] p 443 A95-84783
- Airborne geophysics and precise positioning: Scientific issues and future directions
[LC-94-68678] p 446 N95-27156
- EARTH SURFACE**
Naval Aviation System TEAM mapping, charting, and geodesy handbook
[AD-A288590] p 446 N95-26841
- EDDY CURRENTS**
Extension to the dynamic modeling of the large angle magnetic suspension test fixture
[NASA-CR-197801] p 411 N95-26768
- EDDY VISCOSITY**
Computational analysis of forebody tangential slot blowing on the high alpha research vehicle
[NASA-CR-197754] p 389 N95-26591
- EIGENVALUES**
Aeroelastic stability of wind turbine blade/aileron systems p 377 N95-27981
- ELASTIC DAMPING**
An analytical model for a nonlinear elastomeric lag damper and its effect on aeromechanical stability in Hover
[HTN-95-61076] p 369 A95-83660
- ELASTIC DEFORMATION**
Load transfer in the stiffener-to-skin joints of a pressurized fuselage
[NASA-CR-198610] p 439 N95-27865
- Unique considerations in the design and experimental evaluation of tailored wings with elastically produced chordwise camber p 423 N95-28436
- ELASTOMERS**
Development of a low-cost, modified resin transfer molding process using elastomeric tooling and automated preform fabrication p 420 N95-28268
- ELECTRIC CONNECTORS**
Partial discharge testing of high voltage wiring harness for airborne displays
[AD-A289150] p 401 N95-27003
- ELECTRIC DISCHARGES**
Partial discharge testing of high voltage wiring harness for airborne displays
[AD-A289150] p 401 N95-27003
- ELECTRIC EQUIPMENT TESTS**
Ceramic composite attachments for transmission of high-torque loads
[BTN-94-EIX95011441256] p 417 A95-84213
- Partial discharge testing of high voltage wiring harness for airborne displays
[AD-A289150] p 401 N95-27003
- ELECTRIC GENERATORS**
Development of 70MW class superconducting generators
[BTN-94-EIX95011440854] p 429 A95-82905
- A hybrid vehicle evaluation code and its application to vehicle design. Revision 1
[DE95-008053] p 441 N95-28029
- ELECTRIC MOTORS**
Dynamically timed electric motor
[NASA-CASE-MFS-28958-1] p 437 N95-26890
- ELECTRIC POTENTIAL**
Micro-time stress measurement device development
[AD-A289511] p 448 N95-26845
- Mechanism of deposit formation on fuel-wetted hot metal surfaces
[AD-A289847] p 426 N95-28621
- ELECTRIC POWER SUPPLIES**
Evaluation of all-electric secondary power for transport aircraft
[NASA-CR-189077] p 441 N95-27999

ELECTRIC POWER TRANSMISSION

Ceramic composite attachments for transmission of high-torque loads
[BTN-94-EIX95011441256] p 417 A95-84213

ELECTRICAL ENGINEERING

Development of 70MW class superconducting generators
[BTN-94-EIX95011440854] p 429 A95-82905

ELECTRICAL MEASUREMENT

Micro-time stress measurement device development
[AD-A289511] p 448 N95-26845

ELECTROCHEMISTRY

The use of electrochemistry and ellipsometry for identifying and evaluating corrosion on aircraft
[AD-A288536] p 381 N95-27186

ELECTROMAGNETIC SCATTERING

Hybrid finite element-modal analysis of jet engine inlet scattering
[BTN-95-EIX95242673665] p 427 A95-82259
Analysis of backscattering from wing and fuselage joints
[HTN-95-71134] p 430 A95-83495

ELECTROMAGNETS

Extension to the dynamic modeling of the large angle magnetic suspension test fixture
[NASA-CR-197801] p 411 N95-26768

ELECTRON TRANSFER

A model for temperature-dependent collisional quenching of OH A(sup 2) Sigma(sup +)
[HTN-95-42308] p 450 A95-85002

ELECTRONIC EQUIPMENT

CAE for thermal management of aerospace electronic boards using the BETAsoft program
p 438 N95-27354

ELECTROSTATIC CHARGE

The effect of aviation fuels containing low amounts of static dissipater additive on electrostatic charge generation
[AD-A280075] p 420 N95-28152

ELLIPSONOMETRY

The use of electrochemistry and ellipsometry for identifying and evaluating corrosion on aircraft
[AD-A288536] p 381 N95-27186

ENERGY CONSERVATION

Rarefied gas effects on aerobraking/reentry vehicles with wakes
[NASA-CR-196586] p 415 N95-27093

ENERGY DISSIPATION

The effects of wall perturbations on thermo-turbulent Couette flow
[HTN-95-92255] p 434 A95-85299
Photoacoustic chambers for studying solids and gases: Theory and practical examples
[IFTR-39/1994] p 412 N95-26837

ENERGY TRANSFER

Contribution of thermal radiation to the temperature profile of ceramic composite materials
[BTN-94-EIX95011441252] p 417 A95-84209

ENGINE AIRFRAME INTEGRATION

Development of an upwind, finite-volume code with finite-rate chemistry
[NASA-CR-197747] p 374 N95-26760
Performance study for inlet installations
[NASA-CR-189714] p 406 N95-28227

ENGINE CONTROL

Prevention and control of inlet unstart using an SR-71 simulation
p 367 N95-26948

ENGINE DESIGN

Design features of the NAL ramjet engine test facility
p 410 A95-82319
Aircraft gas turbine emissions challenge
[BTN-94-EIX95011441239] p 403 A95-84196
Control requirements for the RB 211 low-emission combustion system
[BTN-94-EIX95011441244] p 416 A95-84201
Flex cycle combustor development and demonstration
[BTN-94-EIX95011441245] p 417 A95-84202
Development of an aeroderivative gas turbine dry low emissions combustion system
[BTN-94-EIX95011441246] p 417 A95-84203
Charles Norvin Rinek; an early American pioneer in advanced aviation engines
[SAE PAPER 930485] p 386 A95-84554
Experiment on a rectangular cross section scramjet combustor. 2: Effects of fuel injector geometry
[NAL-TR-1220] p 405 N95-26600
Prevention and control of inlet unstart using an SR-71 simulation
p 367 N95-26948
Preliminary results and research capabilities of a new jet facility at the University of Kansas
p 412 N95-26951
Application of CFD to the analysis and design of high-speed inlets
[NASA-CR-198574] p 438 N95-27240

Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics
[NASA-TM-106685] p 416 N95-27434
Composite intermediate case manufacturing scale-up for advanced engines
p 406 N95-28275

ENGINE INLETS

Hybrid finite element-modal analysis of jet engine inlet scattering
[BTN-95-EIX95242673665] p 427 A95-82259
Hypersonic wind tunnel test of sidewall compression type scramjet inlet
p 410 A95-82320
Characteristics of the turbine inlet temperature sensing circuit for the T56 turbo-prop engine
[DSTO-TR-0095] p 405 N95-26424
Performance characterization of a highly-offset diffuser with and without blowing vortex generator jets
[AD-A289334] p 375 N95-26901
Prevention and control of inlet unstart using an SR-71 simulation
p 367 N95-26948
Application of CFD to the analysis and design of high-speed inlets
[NASA-CR-198574] p 438 N95-27240
Performance study for inlet installations
[NASA-CR-189714] p 406 N95-28227
Experimental investigation of inlet-combustor isolators for a dual-mode scramjet at a Mach number of 4
[NASA-TP-3502] p 407 N95-28343

ENGINE MONITORING INSTRUMENTS

Characteristics of the turbine inlet temperature sensing circuit for the T56 turbo-prop engine
[DSTO-TR-0095] p 405 N95-26424

ENGINE NOISE

Aircraft noise prediction program theoretical manual: Rotorcraft System Noise Prediction System (ROTONET), Part 4
[NASA-TM-83199-PT-4] p 451 N95-26392

ENGINE PARTS

Composite intermediate case manufacturing scale-up for advanced engines
p 406 N95-28275
Application of fiber-reinforced bismaleimide materials to aircraft nacelle structures
p 397 N95-28278

ENGINE TESTS

Design features of the NAL ramjet engine test facility
p 410 A95-82319
Experiment of rocket-ram annular combustor
p 412 A95-82324
Life evaluation of a low power arcjet thruster
p 403 A95-82337
Flex cycle combustor development and demonstration
[BTN-94-EIX95011441245] p 417 A95-84202
Effects of dust from storage heaters on ignition in scramjets
[NAL-TR-1234] p 405 N95-26706
Prevention and control of inlet unstart using an SR-71 simulation
p 367 N95-26948

ENGINEERING DRAWINGS

Automatic riveting cell for commercial aircraft floor grid assembly
[HTN-95-92309] p 365 A95-85353

ENGINEERS

Charles Norvin Rinek; an early American pioneer in advanced aviation engines
[SAE PAPER 930485] p 386 A95-84554
Pilot rating scale for aircraft handling qualities
[HTN-95-42269] p 380 A95-84963

ENVIRONMENT PROTECTION

Community relations plan: Galena Airport and Camp ion Air Force Station, Alaska
[AD-A286722] p 446 N95-27234

ENVIRONMENT SIMULATORS

The value of simulation for training
[AD-A289174] p 411 N95-26556

ENVIRONMENTAL TESTS

Pressure and temperature distortion testing of a two-stage centrifugal compressor
[BTN-94-EIX95011441250] p 431 A95-84207

EPOXY RESINS

Scarf joint technique with cocured and precured patches for composite repair
p 396 N95-27524

EQUIPMENT SPECIFICATIONS

Dynamically timed electric motor
[NASA-CASE-MFS-28958-1] p 437 N95-26890

EROSION

Life evaluation of a low power arcjet thruster
p 403 A95-82337

ERROR ANALYSIS

Precision requirement for potential-based panel methods
[HTN-95-51666] p 433 A95-85048
Bearing defect signature analysis using advanced nonlinear signal analysis in a controlled environment
[NASA-TM-108491] p 441 N95-28364

EULER EQUATIONS OF MOTION

Practical formulation of a positively conservative scheme
[HTN-95-51668] p 433 A95-85050

Dynamic unstructured method for flows past multiple objects in relative motion
[BTN-95-EIX95262694303] p 435 A95-85474
Nonreflective boundary conditions for high-order methods
p 371 A95-86157

[HTN-95-42328] p 371 A95-86157
Using the Liou-Steffen algorithm for the Euler and Navier-Stokes equations
[HTN-95-42348] p 373 A95-86177

Computational fluid dynamics and transonic flow
[AD-A288962] p 436 N95-26405

A fixed time performance evaluation of parallel CFD applications
[DE94-014240] p 436 N95-26445

Evaluation of a doubly-swept blade tip for rotorcraft noise reduction
[NASA-CR-189677] p 452 N95-28264

EUROPE

An overview of the EASOE campaign
[HTN-95-00702] p 443 A95-86272

EVALUATION

Part-task simulator evaluations of advanced terrain displays
[SAE PAPER 932570] p 401 A95-84567
Assessment of cost and training effectiveness for a candidate training system using the Comparison-Based Prediction model
[SAE PAPER 932598] p 379 A95-84570

EVAPORATION

A numerical model to predict the fate of jettisoned aviation fuel
[AD-A289336] p 419 N95-26842

EXHAUST DIFFUSERS

Performance characterization of a highly-offset diffuser with and without blowing vortex generator jets
[AD-A289334] p 375 N95-26901

EXHAUST EMISSION

Aircraft gas turbine emissions challenge
[BTN-94-EIX95011441239] p 403 A95-84196
Nitrogen oxide emissions characteristics of augmented turbofan engines
[BTN-94-EIX95011441240] p 403 A95-84197
Development of an aeroderivative gas turbine dry low emissions combustion system
[BTN-94-EIX95011441246] p 417 A95-84203

EXHAUST FLOW SIMULATION

An experimental investigation of scramjet nozzle flow
p 402 A95-82322

EXHAUST GASES

Nitrogen oxide emissions characteristics of augmented turbofan engines
[BTN-94-EIX95011441240] p 403 A95-84197
Evolution of the concentrations of trace species in an aircraft plume: Trajectory study
[HTN-95-A1044] p 443 A95-84549

EXHAUST NOZZLES

An experimental investigation of scramjet nozzle flow
p 402 A95-82322
Preliminary results and research capabilities of a new jet facility at the University of Kansas
p 412 N95-26951

EXPERIMENT DESIGN

Balanced on air aircraft
[AD-D017251] p 389 N95-26537

EXPERT SYSTEMS

Artificial intelligence for turboprop engine maintenance
[HTN-95-92313] p 404 A95-85357
Digital systems validation. Chapter 20 Artificial Intelligence with applications for aircraft. Handbook, volume 2
[AD-A288492] p 448 N95-26638

EXPOSURE

Adhesively bonded composite patch repair of cracked aluminum alloy structures
p 393 N95-27507

EXTERNAL STORE SEPARATION

Dynamic unstructured method for flows past multiple objects in relative motion
[BTN-95-EIX95262694303] p 435 A95-85474

EXTRATERRESTRIAL ENVIRONMENTS

Aero-thermodynamic flight environment at HITEN aerobrace experiment
p 415 A95-82554

EXTRA-VEHICULAR ACTIVITY

Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993
[SAE SP-992] p 417 A95-84553

F**F-14 AIRCRAFT**

Navy composite maintenance and repair experience
p 424 A95-28446

F-15 AIRCRAFT

- Development of a nonlinear simulation for the McDonnell Douglas F-15 Eagle with a longitudinal TECS control-law [AD-A288610] p 388 N95-26481
- Development of a TECS control-law for the lateral directional axis of the McDonnell Douglas F-15 Eagle [AD-A289771] p 410 N95-28598

F-16 AIRCRAFT

- A quantitative feedback theory FCS design for the subsonic envelope of the VISTA F-16 including configuration variation [AD-A289221] p 409 N95-26958
- Flight control design using mixed H2/micron optimization [AD-A289288] p 410 N95-27036
- Implementation and demonstration of a multiple model adaptive estimation failure detection system for the F-16 [AD-A289301] p 391 N95-27042
- Life cycle costs of alternatives for F-16 printed circuit board diagnosis equipment [AD-A288744] p 401 N95-28586

F-18 AIRCRAFT

- Robust longitudinal axis flight control for an aircraft with thrust vectoring [BTN-95-EIX95122538875] p 408 A95-83000
- F/A-18 IFOSTP Fatigue test airbag load determination on the vertical and horizontal tails [DSTO-TR-0135] p 388 N95-26389
- Numerical simulation of the flow about the F-18 HARV at high angle of attack [NASA-CR-197755] p 374 N95-26735
- Composite repair of a CF18: Vertical stabilizer leading edge p 395 N95-27517
- Composite flight-control actuator development p 410 N95-28281

FABRICATION

- R & D on HOPE structure p 413 A95-82355
- Development of a low-cost, modified resin transfer molding process using elastomeric tooling and automated preform fabrication p 420 N95-28268
- Static and fatigue testing of full-scale fuselage panels fabricated using a Therm-X(R) process p 420 N95-28270
- Advanced tow placement of composite fuselage structure p 420 N95-28271
- Resin transfer molding of textile preforms for aircraft structural applications p 421 N95-28276

FAILURE ANALYSIS

- Implementation and demonstration of a multiple model adaptive estimation failure detection system for the F-16 [AD-A289301] p 391 N95-27042
- Bearing defect signature analysis using advanced nonlinear signal analysis in a controlled environment [NASA-TM-108491] p 441 N95-28364
- Technology integration box beam failure study p 441 N95-28468
- Tension fracture of laminates for transport fuselage. Part 1: Material screening p 398 N95-28471
- Application of damage tolerance methodology in certification of the Piaggio P-180 Avanti p 399 N95-28480

FAILURE MODES

- Static and fatigue testing of full-scale fuselage panels fabricated using a Therm-X(R) process p 420 N95-28270
- Proof test methodology for composites p 424 N95-28445
- Numerical simulation of crack growth in pressurized fuselages [PB95-192415] p 400 N95-28636

FALLING

- Study on a scheme for the prolongation of microgravity time of balloon-borne drop capsule p 414 A95-82515

FAN BLADES

- The effects of surface modification on fretting fatigue in Ti alloy turbine components [HTN-95-61145] p 404 A95-84909

FATIGUE (MATERIALS)

- Ceramic composite attachments for transmission of high-torque loads [BTN-94-EIX95011441256] p 417 A95-84213
- The effects of surface modification on fretting fatigue in Ti alloy turbine components [HTN-95-61145] p 404 A95-84909
- Fatigue of aircraft materials; Specialists' Conference, Delft, Netherlands, 1992 p 387 A95-85892
- Fatigue of aircraft materials and structures p 387 A95-85894
- A review of Australian and New Zealand investigations on aeronautical fatigue during the period Apr. 1993 - Mar. 1995 [AR-009-202] p 397 N95-27918
- Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system p 440 N95-27983

- Prediction of fatigue crack growth under constant amplitude and random loading using specimens with multiple cracks [AD-A291614] p 397 N95-28409
- Investigation of static and cyclic bearing failure mechanisms for GR/EP laminates p 422 N95-28427
- Applications of a damage tolerance analysis methodology in aircraft design and production p 426 N95-28483

FATIGUE LIFE

- Flight simulation fatigue crack growth testing of aluminum alloys [HTN-95-00652] p 418 A95-84731
- The effects of surface modification on fretting fatigue in Ti alloy turbine components [HTN-95-61145] p 404 A95-84909
- Artificial neural networks for predicting nonlinear dynamic helicopter loads [HTN-95-51678] p 404 A95-85060

FATIGUE TESTS

- Flight simulation fatigue crack growth testing of aluminum alloys [HTN-95-00652] p 418 A95-84731
- Status and prospects for aluminum-lithium alloys in aircraft structures p 387 A95-85893
- Fibre-Metal laminates p 387 A95-85895
- Elements of structural integrity assurance p 387 A95-85896
- Design and development of a test rig for the high frequency testing of rolling sleeve airsprings [DSTO-TN-0001] p 411 N95-26378
- F/A-18 IFOSTP Fatigue test airbag load determination on the vertical and horizontal tails [DSTO-TR-0135] p 388 N95-26389
- Composite repair of metallic airframe: Twenty years of experience p 393 N95-27508
- External patch repair of CFRP/honeycomb sandwich p 395 N95-27522
- Damage occurrence on composites during testing and fleet service: Repair of Airbus aircraft p 396 N95-27526
- Static and fatigue testing of full-scale fuselage panels fabricated using a Therm-X(R) process p 420 N95-28270
- Proof test methodology for composites p 424 N95-28445
- Applications of a damage tolerance analysis methodology in aircraft design and production p 426 N95-28483

FAULT DETECTION

- Condition monitoring and diagnostics [HTN-95-92312] p 387 A95-85356
- SMART materials: Surfaces, transforms and interfaces. The commensurate engineering dimension [AD-A289598] p 442 N95-28649

FEEDBACK

- Electro-hydrostatic actuator controller design using quantitative feedback theory [AD-A289220] p 409 N95-26957
- A quantitative feedback theory FCS design for the subsonic envelope of the VISTA F-16 including configuration variation [AD-A289221] p 409 N95-26958
- Transonic flutter suppression using active acoustic excitations [BTN-95-EIX95262694310] p 408 A95-85481
- Scheduling of local nonlinear control laws by exogenous signals - an application to flight control [BTN-95-EIX95262694059] p 447 A95-85675
- A gain scheduling optimization method using genetic algorithms [AD-A289306] p 448 N95-26920
- Advanced formation flight control [AD-A289271] p 409 N95-26981

FIBER COMPOSITES

- Shear buckling response of tailored composite plates [HTN-95-51680] p 418 A95-85062
- Fatigue of aircraft materials; Specialists' Conference, Delft, Netherlands, 1992 [HTN-95-B0076] p 387 A95-85892
- Fibre-Metal laminates p 387 A95-85895
- On aircraft repair verification of a fighter A/C integrally stiffened fuselage skin p 394 N95-27515
- Composite repair of a CF18: Vertical stabilizer leading edge p 395 N95-27517
- Scarf joint technique with cocured and precured patches for composite repair p 396 N95-27524
- Composite or metallic bolted repairs on self-stiffened carbon wing panel of the commuter ATR72 design criteria, analysis, verification by test p 396 N95-27525
- Repairs of CFC primary structures p 396 N95-27527
- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 3 [NASA-CR-198718] p 420 N95-28266

- Analysis of aircraft engine blade subject to ice impact p 407 N95-28277

- Application of fiber-reinforced bismaleimide materials to aircraft nacelle structures p 397 N95-28278
- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 1 [NASA-CR-198723] p 421 N95-28420

- Application of advanced material systems to composite frame elements p 422 N95-28432
- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 2 [NASA-CR-198722] p 424 N95-28462
- Advanced wing design survivability testing and results p 400 N95-28488

- Ceramic composite combustor cans for expendable turbine engines [AD-A289551] p 407 N95-28646

FIBER OPTICS

- SMART materials: Surfaces, transforms and interfaces. The commensurate engineering dimension [AD-A289598] p 442 N95-28649

FIBER ORIENTATION

- Shear buckling response of tailored composite plates [HTN-95-51680] p 418 A95-85062

FIGHTER AIRCRAFT

- T-45A high angle attack testing [HTN-95-81499] p 386 A95-85213
- Integrated mission precision attack cockpit technology (IMPACT). Phase 1: Identifying technologies for air-to-ground fighter integration [AD-A289562] p 389 N95-26684
- Performance study for inlet installations [NASA-CR-189714] p 406 N95-28227
- Structural design optimization with survivability dependent constraints application: Primary wing box of a multi-role fighter p 398 N95-28440

FILM BOILING

- Study of heat transfer rates during quenching of a hot tube under microgravity p 428 A95-82641
- Experimental investigation of flow-boiling heat transfer under microgravity p 428 A95-82642

FILM COOLING

- Study on the turbine vane and blade for a 1500 C class industrial gas turbine [BTN-94-EIX95011441254] p 431 A95-84211
- Flowfield measurements in supersonic film cooling including the effect of shock-wave interaction [HTN-95-42337] p 405 A95-86166
- A summary of computational experience at GE Aircraft Engines for complex turbulent flows in gas turbines p 439 N95-27885

FINITE DIFFERENCE THEORY

- Development of an upwind, finite-volume code with finite-rate chemistry [NASA-CR-197747] p 374 N95-26760
- A numerical method for unsteady transonic flow about wings with control surfaces [AD-A289631] p 375 N95-26859

FINITE ELEMENT METHOD

- Hybrid finite element-modal analysis of jet engine inlet scattering [BTN-95-EIX95242673665] p 427 A95-82259
- Accuracy and efficiency assessments for a weak statement CFD algorithm for high-speed aerodynamics [BTN-94-EIX95011441238] p 370 A95-84195
- Thermo-hydrodynamic solution of floating ring seals for high pressure compressors using the finite-element method [HTN-95-92246] p 433 A95-85290
- A verification procedure for MSC/NASTRAN Finite Element Models [NASA-CR-4675] p 392 N95-27371
- A FEAM based methodology for analyzing composite patch repairs of metallic structures p 394 N95-27511
- Scarf repairs to graphite/epoxy components p 396 N95-27523
- A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines p 439 N95-27980
- Aeroelasticity and structural optimization of composite helicopter rotor blades with swept tips [NASA-CR-4665] p 397 N95-28262
- TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document [NASA-CR-4348] p 378 N95-28265
- Analysis techniques for the prediction of springback in formed and bonded composite components p 421 N95-28289

FINITE VOLUME METHOD

- Numerical investigation to S-inlet flows (Numerical simulation study of S-inlet flows) [AD-A289590] p 374 N95-26713

FINS

A study on aerodynamic heating phenomena in three-dimensional shock wave/turbulent boundary layer interaction induced by sweptback sharp fins at supersonic flow p 428 A95-82419

Application of damage tolerance methodology in certification of the Piaggio P-180 Avanti p 399 N95-28480

FIRE DAMAGE

Mapping of forest fire damages using imaging spectroscopy p 442 A95-83627

FIXED WINGS

Comparison of fixed wing aircraft algorithms for JANUS p 389 N95-26652
Test operations procedure (TOP) 7-3-534 airworthiness testing of fixed wing aircraft: Asymmetric power testing [AD-A289458] p 391 N95-26994

FIXING

Compressive strength of damaged and repaired composite plates p 442 A95-28484

FIXTURES

Extension to the dynamic modeling of the large angle magnetic suspension test fixture [NASA-CR-197801] p 411 N95-26768

FLAME HOLDERS

Numerical simulation of combustion flow around a flame holder with hydrogen injection [NAL-TR-1233] p 419 N95-26523

FLAME PROPAGATION

Stationary premixed flames in spherical and cylindrical geometries [HTN-95-42336] p 418 A95-86165

FLAMMABLE GASES

Stationary premixed flames in spherical and cylindrical geometries [HTN-95-42336] p 418 A95-86165

FLANGES

Application of advanced material systems to composite frame elements p 422 N95-28432

FLAPERONS

Full span flaperons for a biplane p 391 N95-26954

FLAPPING

Visualization of the multiple supersonic jet oscillations by swept focused strobed schlieren technique p 367 N95-26952

FLAPS (CONTROL SURFACES)

Comparative wind tunnel tests of NACA 23024 airfoils with several aileron and spoiler configurations p 376 N95-27976

FLAT PLATES

Flow past a symmetric wedge with forward splitter plate p 427 A95-82406

Two-dimensional viscous flow past a flat plate [HTN-95-42210] p 430 A95-84026

Free convection past a uniform flux surface inclined at a small angle to the horizontal p 430 A95-84029

Shear buckling response of tailored composite plates [HTN-95-51680] p 418 A95-85062

Plate manipulators p 374 N95-26719

Measurements of store forces and moments and cavity pressures for a generic store in and near a box cavity at subsonic and transonic speeds p 378 N95-28241

Construction and wind tunnel test of a 1/12th scale helicopter model [AD-A288487] p 378 N95-28331

FLIGHT CHARACTERISTICS

Atmospheric reentry flight test of winged space vehicle p 414 A95-82483

Flying qualities development and flight simulation evaluation of the TW-68 tilt-wing VTOL aircraft [SAE PAPER 932517] p 386 A95-84555

Condition monitoring and diagnostics [HTN-95-92312] p 387 A95-85356

Simulation model of the integrated flight/propulsion control system, displays, and propulsion system for ASTOVL lift-fan aircraft [NASA-TM-108866] p 405 N95-26412

A comparison of the Neal-Smith and omega Tau function, zeta function and tau function flying qualities criteria p 390 N95-26844

FLIGHT CONDITIONS

Electro-hydrostatic actuator controller design using quantitative feedback theory p 409 N95-26957

Construction and wind tunnel test of a 1/12th scale helicopter model [AD-A288487] p 378 N95-28331

FLIGHT CONTROL

Nonlinear observer and its application in flight control p 447 A95-82449

Atmospheric reentry flight test of winged space vehicle p 414 A95-82483

Scheduling of local nonlinear control laws by exogenous signals - an application to flight control [BTN-95-EIX95262694059] p 447 A95-85675

Development of a nonlinear simulation for the McDonnell Douglas F-15 Eagle with a longitudinal TECS control-law [AD-A288610] p 388 N95-26481

Design and synthesis of a real-time controller for an unmanned air vehicle p 408 N95-26555

An investigation of the effects of pitch-roll (de)coupling on helicopter handling qualities [NASA-TM-110349] p 409 N95-26773

A comparison of the Neal-Smith and omega Tau function, zeta function and tau function flying qualities criteria p 390 N95-26844

Electro-hydrostatic actuator controller design using quantitative feedback theory p 409 N95-26957

A quantitative feedback theory FCS design for the subsonic envelope of the VISTA F-16 including configuration variation p 409 N95-26958

Advanced formation flight control [AD-A289271] p 409 N95-26981

Flight control design using mixed H2/micron optimization [AD-A289288] p 410 N95-27036

Advanced flight computer. Special study [NASA-CR-198165] p 449 N95-27246

JPRS report: Science and technology. Central Eurasia [JPRS-UST-94-022] p 438 N95-27699

Operator modeling in commercial aviation: Cognitive models, intelligent displays, and pilot's assistants [NASA-CR-198609] p 401 N95-28203

Composite flight-control actuator development p 410 N95-28281

FLIGHT CREWS

Integrated flight crew transition training for the advanced flight deck aircraft [SAE PAPER 932599] p 380 A95-84571

An analysis of the KC-135 three-person cockpit [AD-A289540] p 390 N95-26873

FLIGHT ENVELOPES

Robust longitudinal axis flight control for an aircraft with thrust vectoring [BTN-95-EIX95122538875] p 408 A95-83000

Flutter clearance flight tests of an OV-10A airplane modified for wake vortex flight experiments [NASA-TM-109168] p 366 N95-26381

A quantitative feedback theory FCS design for the subsonic envelope of the VISTA F-16 including configuration variation p 409 N95-26958

FLIGHT HAZARDS

A review of falconry as a bird control technique with recommendations for use at the Shuttle Landing Facility, John F. Kennedy Space Center, Florida, USA [NASA-TM-110142] p 381 N95-27859

FLIGHT INSTRUMENTS

Hardware cleanliness methodology and certification p 419 N95-27656

FLIGHT MANAGEMENT SYSTEMS

The CBT alternative for aviation training: Is it meeting the need? [SAE PAPER 932596] p 379 A95-84568

Operator modeling in commercial aviation: Cognitive models, intelligent displays, and pilot's assistants [NASA-CR-198609] p 401 N95-28203

FLIGHT MECHANICS

The CBT alternative for aviation training: Is it meeting the need? [SAE PAPER 932596] p 379 A95-84568

Flight Mechanics/Estimation Theory Symposium 1995 [NASA-CP-3299] p 416 N95-27763

FLIGHT PATHS

Polar Patrol Balloon system and preliminary experimental results p 368 A95-82513

Flightpath synthesis and HUD scaling for V/STOL terminal area operations [NASA-TM-110348] p 383 N95-26587

FLIGHT SAFETY

The 1994 updated National Airspace System performance assessment for year 2005 [AD-A288652] p 380 N95-26485

The effect of aviation fuels containing low amounts of static dissipative additive on electrostatic charge generation [AD-A280075] p 420 N95-28152

FLIGHT SIMULATION

Design features of the NAL ramjet engine test facility p 410 A95-82319

Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993

[SAE SP-992] p 417 A95-84553

Flying qualities development and flight simulation evaluation of the TW-68 tilt-wing VTOL aircraft [SAE PAPER 932517] p 386 A95-84555

Integrated flight crew transition training for the advanced flight deck aircraft [SAE PAPER 932599] p 380 A95-84571

New tools for creating instruction and simulations [SAE PAPER 932600] p 380 A95-84572

Flight simulation fatigue crack growth testing of aluminum alloys [HTN-95-00652] p 418 A95-84731

Verification of the damage tolerance of a fighter aircraft p 388 A95-85897

Simulation model of the integrated flight/propulsion control system, displays, and propulsion system for ASTOVL lift-fan aircraft [NASA-TM-108866] p 405 N95-26412

Development of a nonlinear simulation for the McDonnell Douglas F-15 Eagle with a longitudinal TECS control-law [AD-A288610] p 388 N95-26481

Integrated mission precision attack cockpit technology (IMPACT). Phase 1: Identifying technologies for air-to-ground fighter integration [AD-A289562] p 389 N95-26684

The photo-realistic AFIT virtual cockpit [AD-A289376] p 390 N95-26876

Implementation and demonstration of a multiple model adaptive estimation failure detection system for the F-16 [AD-A289301] p 391 N95-27042

The lift-fan aircraft: Lessons learned [NASA-CR-196694] p 392 N95-27143

A study of workstation computational performance for real-time flight simulation [NASA-TM-109184] p 449 N95-27241

FLIGHT SIMULATORS

The large radius track centrifuge concept as an acceleration research and simulation device p 379 A95-84560

Part-task simulator evaluations of advanced terrain displays [SAE PAPER 932570] p 401 A95-84567

The photo-realistic AFIT virtual cockpit [AD-A289376] p 390 N95-26876

The effects of UH-1 experience on UH-60 simulator performance: A preliminary study [AD-A289457] p 391 N95-26993

Flight control design using mixed H2/micron optimization [AD-A289288] p 410 N95-27036

FLIGHT TESTS

Air data sensors for atmospheric reentry flight test of winged space vehicle p 413 A95-82412

Flight evaluation of DGPS and DGPS-INS navigation systems p 382 A95-82462

A concept of a hypersonic flight experiment of a winged vehicle p 414 A95-82477

A conceptual design of hypersonic research vehicle with subscale scramjet engine p 384 A95-82482

Atmospheric reentry flight test of winged space vehicle p 414 A95-82483

Development and flight results of fiber reinforced balloon p 384 A95-82511

Recent developments in nylon superpressure balloons p 385 A95-82512

Polar Patrol Balloon system and preliminary experimental results p 368 A95-82513

The short range attack missile/light weight exo-atmospheric projectile (SRAM/LEAP) missile tests program [HTN-95-81498] p 386 A95-85212

Flutter clearance flight tests of an OV-10A airplane modified for wake vortex flight experiments [NASA-TM-109168] p 366 N95-26381

Flight evaluation of GPS/DGPS sensor systems installed in NAL Do228 [NAL-TR-1230] p 382 N95-26585

The effects of UH-1 experience on UH-60 simulator performance: A preliminary study [AD-A289457] p 391 N95-26993

Test operations procedure (TOP) 7-3-534 airworthiness testing of fixed wing aircraft: Asymmetric power testing [AD-A289458] p 391 N95-26994

Status of bonded boron/epoxy doublers for military and commercial aircraft structures p 393 N95-27506

Unmanned aerial vehicles, 1994 master plan [AD-A291628] p 398 N95-28411

Proceedings of the AIAA/FAA joint symposium on general aviation systems [AD-A289830] p 368 N95-28610

FLIGHT TRAINING

- Education, training, and human engineering in aerospace: SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993
[SAE SP-992] p 417 A95-84553
Intelligent flight trainer for initial rotary wing training
[SAE PAPER 932536] p 386 A95-84558
Automated hover training: An empirical evaluation
[SAE PAPER 932536] p 379 A95-84559
The CBT alternative for aviation training: Is it meeting the need?
[SAE PAPER 932596] p 379 A95-84568
Assessment of cost and training effectiveness for a candidate training system using the Comparison-Based Prediction model
[SAE PAPER 932598] p 379 A95-84570
Integrated flight crew transition training for the advanced flight deck aircraft
[SAE PAPER 932599] p 380 A95-84571
The value of simulation for training
[AD-A289174] p 411 A95-26556

FLOORS

- Automatic riveting cell for commercial aircraft floor grid assembly
[HTN-95-92309] p 365 A95-85353
Effects of floor location on response of composite fuselage frames
p 423 A95-28439

FLOUQUET THEOREM

- Fast Floquet theory and trim for multi-bladed rotorcraft
[HTN-95-61078] p 370 A95-83662
Aeroelasticity and structural optimization of composite helicopter rotor blades with swept tips
[NASA-CR-4665] p 397 A95-28262

FLOW CHARACTERISTICS

- Viscous shock-layer analysis on hypersonic flow over reentry capsule with nonequilibrium chemistry
[ISAS-656] p 436 A95-26739
Wind tunnel experiments on wake flow field behind a reentry capsule from a viewpoint of parachute deployment at supersonic speeds
[ISAS-655] p 374 A95-26740

FLOW DISTRIBUTION

- An experimental investigation of scramjet nozzle flow
p 402 A95-82322
Numerical analysis of flow field around gas rudder
p 407 A95-82333
Rarefied gas numerical wind tunnel: OREX and HOPE
p 427 A95-82391
VSL analysis of hypersonic flows around a reentry vehicle with equilibrium air chemistry
p 413 A95-82400

- Flow past a symmetric wedge with forward splitter plate
p 427 A95-82406

- A study on aerodynamic heating phenomena in three-dimensional shock wave/turbulent boundary layer interaction induced by sweptback sharp fins at supersonic flow
p 428 A95-82419

- Studies on gain performance of a combustion driven CO₂ gas dynamic laser
p 428 A95-82679
Measurements of vortex pair interaction with a clean or contaminated free surface
p 429 A95-82798
[BTN-94-EIX95011441063]

- Two-dimensional viscous flow past a flat plate
[HTN-95-42210] p 430 A95-84026
Structure of supersonic jet flow and its radiated sound
[HTN-95-51645] p 431 A95-85027

- Computational/experimental investigation of staged injection into a Mach 2 flow
[HTN-95-51646] p 432 A95-85028

- Reattachment studies of an oscillating airfoil dynamic stall flowfield
[HTN-95-51660] p 432 A95-85042

- Crossflow topology of vortical flows
[HTN-95-51664] p 432 A95-85046

- Practical formulation of a positively conservative scheme
[HTN-95-51668] p 433 A95-85050

- Numerical investigation of cylinder wake flow with a rear stagnation jet
[HTN-95-51669] p 433 A95-85051

- Flowfield measurements in supersonic film cooling including the effect of shock-wave interaction
[HTN-95-42337] p 405 A95-86166

- Interferometric investigations of compressible dynamic stall over a transiently pitching airfoil
[HTN-95-42338] p 372 A95-86167

- Numerical simulation of the SOFIA flow field
[NASA-CR-197757] p 436 A95-26589

- CFD research, parallel computation and aerodynamic optimization
[NASA-CR-197748] p 373 A95-26649

- Wind tunnel experiments on wake flow field behind a reentry capsule from a viewpoint of parachute deployment at supersonic speeds
[ISAS-655] p 374 A95-26740

- Rarefied gas effects on aerobraking/reentry vehicles with wakes
[NASA-CR-196586] p 415 A95-27093

- Global flowfield about the V-22 Tiltrotor Aircraft
[NASA-CR-198603] p 375 A95-27248

- Measurements of store forces and moments and cavity pressures for a generic store in and near a box cavity at subsonic and transonic speeds
[NASA-TM-4611] p 378 A95-28241

- TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document
[NASA-CR-4348] p 378 A95-28265

- Numerical analysis of intra-cavity and power-stream flow interaction in multiple gas-turbine disk-cavities
[NASA-TM-106886] p 407 A95-28344

FLOW MEASUREMENT

- Observation of traveling waves in the three-dimensional boundary layer along a yawed cylinder
[HTN-95-61064] p 430 A95-83648

FLOW STABILITY

- Multiple instabilities of three-dimensional boundary layers along a concave wall
[HTN-95-71126] p 429 A95-83487
Screech tones from free and ducted supersonic jets
[HTN-95-51647] p 432 A95-85029
Transition correlations in three-dimensional boundary layers
[HTN-95-51648] p 432 A95-85030

FLOW THEORY

- Hypersonic flow simulation with thermoelectric effect
p 368 A95-82669

FLOW VELOCITY

- On the influence of time-varying flow velocity on unsteady aerodynamics
[HTN-95-61073] p 369 A95-83657

- Numerical investigation of cylinder wake flow with a rear stagnation jet
[HTN-95-51669] p 433 A95-85051

- Development of a large-aspect-ratio rectangular turbulent free jet
[HTN-95-42333] p 372 A95-86162

- An investigation of the AFIT 2-inch shock tube as a flow source for supersonic testing
[AD-A289246] p 412 A95-26966

- NASA Dryden flow visualization facility
[NASA-TM-4631] p 449 A95-27914

FLOW VISUALIZATION

- Hypersonic wind tunnel test of sidewall compression type scramjet inlet
p 410 A95-82320

- Measurements of vortex pair interaction with a clean or contaminated free surface
[BTN-94-EIX95011441063] p 429 A95-82798

- Plate manipulators
[AD-A289601] p 374 A95-26719

- Visualization of the multiple supersonic jet oscillations by swept focused strobed schlieren technique
p 367 A95-26952

- NASA Dryden flow visualization facility
[NASA-TM-4631] p 449 A95-27914

- Measurements of store forces and moments and cavity pressures for a generic store in and near a box cavity at subsonic and transonic speeds
[NASA-TM-4611] p 378 A95-28241

FLUID DYNAMICS

- Numerical analysis of flow field around gas rudder
p 407 A95-82333

- Rarefied gas numerical wind tunnel: OREX and HOPE
p 427 A95-82391

- A study on aerodynamic heating phenomena in three-dimensional shock wave/turbulent boundary layer interaction induced by sweptback sharp fins at supersonic flow
p 428 A95-82419

- Force and moment on a Joukowski profile in the presence of point vortices
[BTN-95-EIX95262694298] p 434 A95-85469

- A non-iterative grid deformation algorithm for computational fluid dynamics for aeroelasticity
[AD-A288298] p 436 A95-26418

- Demonstration study of hierarchical control of fluid-dynamic phenomena
[AD-A289341] p 437 A95-26751

- Basic studies in turbulent shear flows
[AD-A289145] p 437 A95-26998

FLUID FILMS

- Transport phenomena and interfacial kinetics in multiphase combustion systems
[AD-A288297] p 418 A95-26417

FLUID FLOW

- Experimental investigation of composite channel heat pipe operation in micro-gravity environment
p 428 A95-82645

- Pressure and temperature distortion testing of a two-stage centrifugal compressor
[BTN-94-EIX95011441250] p 431 A95-84207

FLUID MECHANICS

- Experimental investigation of composite channel heat pipe operation in micro-gravity environment
p 428 A95-82645

FLUID PRESSURE

- Two-dimensional viscous flow past a flat plate
[HTN-95-42210] p 430 A95-84026

FLUTTER

- Aeroelasticity of wing and wing-body configurations on parallel computers
[NASA-CR-197756] p 389 A95-26590

- Nonlinear dynamics and aeroelasticity of rotorcraft in forward flight
[AD-A291714] p 400 A95-28504

FLUTTER ANALYSIS

- Aeroelastic stability of cascades in turbomachinery
[HTN-95-61156] p 405 A95-86255

- Flutter clearance flight tests of an OV-10A airplane modified for wake vortex flight experiments
[NASA-TM-109168] p 366 A95-26381

FLY BY WIRE CONTROL

- Evaluation of all-electric secondary power for transport aircraft
[NASA-CR-189077] p 441 A95-27999

FLYWHEELS

- A hybrid vehicle evaluation code and its application to vehicle design. Revision 1
[DE95-008053] p 441 A95-28029

FORCED CONVECTION

- Convection heat transfer distributions over plates with square ribs from infrared thermography measurements
[HTN-95-20713] p 435 A95-86603

FOREBODIES

- Surface interference in Rayleigh scattering measurements near forebodies
[HTN-95-51670] p 433 A95-85052

- Computational analysis of forebody tangential slot blowing on the high alpha research vehicle
[NASA-CR-197754] p 389 A95-26591

FOREST FIRES

- Mapping of forest fire damages using imaging spectroscopy
p 442 A95-83627

FORMING TECHNIQUES

- Forming and bonding techniques for high-strength aluminum alloys
[HTN-95-20605] p 418 A95-84786

FOURIER SERIES

- Load transfer in the stiffener-to-skin joints of a pressurized fuselage
[NASA-CR-198610] p 439 A95-27865

FRACTALS

- Fractal properties of whitecaps
[HTN-95-92121] p 443 A95-83827

FRACTURE STRENGTH

- Status and prospects for aluminium-lithium alloys in aircraft structures
p 387 A95-85893

FRACTURING

- Tension fracture of laminates for transport fuselage. Part 1: Material screening
p 398 A95-28471

FRAMES

- Application of advanced material systems to composite frame elements
p 422 A95-28432

- Effects of floor location on response of composite fuselage frames
p 423 A95-28439

FREE FLOW

- On the influence of time-varying flow velocity on unsteady aerodynamics
[HTN-95-61073] p 369 A95-83657

FREE JETS

- Screech tones from free and ducted supersonic jets
[HTN-95-51647] p 432 A95-85029

- Stochastic approach to noise modeling for free turbulent flows
[HTN-95-42321] p 371 A95-86150

- Development of a large-aspect-ratio rectangular turbulent free jet
[HTN-95-42333] p 372 A95-86162

- Preliminary results and research capabilities of a new jet facility at the University of Kansas
p 412 A95-26951

FREQUENCIES

- Prediction of fatigue crack growth under constant amplitude and random loading using specimens with multiple cracks
[AD-A291614] p 397 A95-28409

FRETTING

- The effects of surface modification on fretting fatigue in Ti alloy turbine components
[HTN-95-61145] p 404 A95-84909

FUEL COMBUSTION

- Pressure and temperature distortion testing of a two-stage centrifugal compressor
[BTN-94-EIX95011441250] p 431 A95-84207

FUEL CORROSION

- Characterization of corrosion and development of a breadboard of a D sight aircraft inspection system, phase 1
[AD-A288347] p 380 N95-26527

FUEL INJECTION

- Numerical simulation of combustion flow around a flame holder with hydrogen injection
[NAL-TR-1233] p 419 N95-26523
Experiment on a rectangular cross section scramjet combustor. 2: Effects of fuel injector geometry
[NAL-TR-1220] p 405 N95-26600

FUEL SYSTEMS

- Development of an aeroderivative gas turbine dry low emissions combustion system
[BTN-94-EIX95011441246] p 417 A95-84203
Rotorcraft crashworthy airframe and fuel system technology development program
[AD-A289986] p 382 N95-28630

FUELS

- Transport phenomena and interfacial kinetics in multiphase combustion systems
[AD-A288297] p 418 N95-26417
Proceedings of the AIAA/FAA joint symposium on general aviation systems
[AD-A289830] p 368 N95-28610

FULL SCALE TESTS

- Structural modification and repair of C-130 wing structure using bonded composites p 394 N95-27512
Report to Congressional Committees. Comanche Helicopter: Testing needs to be completed prior to production decisions
[GAO/NSIAD-95-112] p 397 N95-27910
Comparative wind tunnel tests of NACA 23024 airfoils with several aileron and spoiler configurations
p 376 N95-27976

FUNCTIONAL DESIGN SPECIFICATIONS

- Mobile domes for TACTIC telescope p 453 A95-86113

FUSELAGES

- Analysis of backscattering from wing and fuselage joints
[HTN-95-71134] p 430 A95-83495
Considerations in the development of the coupled rotor fuselage model
[HTN-95-61077] p 370 A95-83661
Characterization of corrosion and development of a breadboard of a D sight aircraft inspection system, phase 1
[AD-A288347] p 380 N95-26527
On aircraft repair verification of a fighter A/C integrally stiffened fuselage skin
p 394 N95-27515
Load transfer in the stiffener-to-skin joints of a pressurized fuselage
[NASA-CR-198610] p 439 N95-27865
Static and fatigue testing of full-scale fuselage panels fabricated using a Therm-X(R) process
p 420 N95-28270
Advanced tow placement of composite fuselage structure
p 420 N95-28271
ACT/ICAPS: Thermoplastic composite activities
p 421 N95-28274
The effect of material heterogeneity in curved composite beams for use in aircraft structures p 422 N95-28426
Effects of floor location on response of composite fuselage frames p 423 N95-28439
Probabilistic evaluation of fuselage-type composite structures p 398 N95-28444
Composite fuselage shell structures research at NASA Langley Research Center p 425 N95-28466
Test and analysis results for composite transport fuselage and wing structures p 398 N95-28470
Tension fracture of laminates for transport fuselage. Part 1: Material screening p 398 N95-28471
Local design optimization for composite transport fuselage crown panels p 398 N95-28473
Composite fuselage crown panel manufacturing technology p 399 N95-28474
Advanced textile applications for primary aircraft structures p 399 N95-28476
Characterization and manufacture of braided composites for large commercial aircraft structures p 426 N95-28478
Impact damage resistance of composite fuselage structure, part 1 p 399 N95-28482
Damage tolerance of a geodesically stiffened advanced composite structural concept for aircraft structural applications p 399 N95-28487
Rotorcraft crashworthy airframe and fuel system technology development program
[AD-A289986] p 382 N95-28630
Numerical simulation of crack growth in pressurized fuselages
[PB95-192415] p 400 N95-28636

FUZZY SYSTEMS

- Digital systems validation. Chapter 20 Artificial Intelligence with applications for aircraft. Handbook, volume 2
[AD-A288492] p 448 N95-26638

G**GALERKIN METHOD**

- Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils
[NASA-TP-3496] p 378 N95-28674

GAMMA RAY TELESCOPES

- Mobile domes for TACTIC telescope p 453 A95-86113

GAS DYNAMICS

- Studies on gain performance of a combustion driven CO₂ gas dynamic laser p 428 A95-82679

GAS EXPANSION

- Experiment of rocket-ram annular combustor p 412 A95-82324
The noise reduction potential of dual-stream coaxial rectangular improperly expanded jet flows
[NASA-CR-197820] p 437 N95-26995

GAS FLOW

- Numerical analysis of flow field around gas rudder p 407 A95-82333
Rarefied gas numerical wind tunnel: OREX and HOPE p 427 A95-82391

GAS GENERATORS

- Evaluation of scramjet nozzle performance p 402 A95-82321

GAS INJECTION

- Hypersonic thermal protection with mass injection at angle of attack p 414 A95-82414
Computational/experimental investigation of staged injection into a Mach 2 flow
[HTN-95-51646] p 432 A95-85028
Quantitative investigation of compressible mixing: Staged transverse injection into Mach 2 flow
[HTN-95-42330] p 404 A95-86159
Flowfield measurements in supersonic film cooling including the effect of shock-wave interaction
[HTN-95-42337] p 405 A95-86166

GAS MIXTURES

- General solution procedure for flows in local chemical equilibrium
[HTN-95-42329] p 404 A95-86158

GAS PRESSURE

- An investigation of the AFIT 2-inch shock tube as a flow source for supersonic testing
[AD-A289246] p 412 N95-26966

GAS TURBINE ENGINES

- GETRAN: A generic, modularly structured computer code for simulation of dynamic behavior of aero- and power generation gas turbine engines
[BTN-94-EIX95011441241] p 431 A95-84198
Flex cycle combustor development and demonstration
[BTN-94-EIX95011441245] p 417 A95-84202
Development of an aeroderivative gas turbine dry low emissions combustion system
[BTN-94-EIX95011441246] p 417 A95-84203
Study on the turbine vane and blade for a 1500 C class industrial gas turbine
[BTN-94-EIX95011441254] p 431 A95-84211
The effects of surface modification on fretting fatigue in Ti alloy turbine components
[HTN-95-61145] p 404 A95-84909
Applying nanostructured materials to future gas turbine engines
[HTN-95-11909] p 404 A95-85990
Transport phenomena and interfacial kinetics in multiphase combustion systems
[AD-A288297] p 418 N95-26417
Optimization of wave rotors for use as gas turbine engine topping cycles
[NASA-TM-106951] p 406 N95-27860
A summary of computational experience at GE Aircraft Engines for complex turbulent flows in gas turbines p 439 N95-27885
Composite intermediate case manufacturing scale-up for advanced engines p 406 N95-28275

GAS TURBINES

- Numerical analysis of intra-cavity and power-stream flow interaction in multiple gas-turbine disk-cavities
[NASA-TM-106886] p 407 N95-28344

GASES

- Development of an upwind, finite-volume code with finite-rate chemistry
[NASA-CR-197747] p 374 N95-26760
Photoacoustic chambers for studying solids and gases: Theory and practical examples
[IFTR-39/1994] p 412 N95-26837

GASOLINE

- A hybrid vehicle evaluation code and its application to vehicle design. Revision 1
[DE95-008053] p 441 N95-28029

GEARS

- Vibration analysis of a split path gearbox
[NASA-TM-106875] p 438 N95-27855

GENERAL AVIATION AIRCRAFT

- Proceedings of the AIAA/FAA joint symposium on general aviation systems
[AD-A289830] p 368 N95-28610

GENETIC ALGORITHMS

- A gain scheduling optimization method using genetic algorithms
[AD-A289306] p 448 N95-26920

GEODESIC LINES

- Damage tolerance of a geodesically stiffened advanced composite structural concept for aircraft structural applications p 399 N95-28487

GEODESY

- Naval Aviation System TEAM mapping, charting, and geodesy handbook
[AD-A288590] p 446 N95-26841

GEOMETRIC DILUTION OF PRECISION

- Determining GPS average performance metrics p 383 N95-27791

GEOPHYSICS

- Data processing and mapping in airborne radiometric surveys
[HTN-95-51587] p 442 A95-83591
Airborne geophysics and precise positioning: Scientific issues and future directions
[LC-94-68678] p 446 N95-27156
Geophex airborne unmanned survey system
[DE95-007566] p 392 N95-27440

GLASS FIBERS

- Scarf joint technique with cocured and precured patches for composite repair p 396 N95-27524
Utilization of composite materials by the US Army: A look ahead p 421 N95-28421

GLIDERS

- Sailplane glide performance and control using fixed and articulating winglets
[NASA-CR-198579] p 392 N95-27180

GLIDING

- Sailplane glide performance and control using fixed and articulating winglets
[NASA-CR-198579] p 392 N95-27180

GLOBAL POSITIONING SYSTEM

- Flight evaluation of DGPS and DGPS-INS navigation systems p 382 A95-82462
Flight evaluation of GPS/DGPS sensor systems installed in NAL Do228
[NAL-TR-1230] p 382 N95-26585
Analysis and simulation of narrowband GPS jamming using digital excision temporal filtering
[AD-A289328] p 383 N95-26898
Flight Mechanics/Estimation Theory Symposium 1995
[NASA-CP-3299] p 416 N95-27763
Determining GPS average performance metrics p 383 N95-27791

GOERTLER INSTABILITY

- Instability of three-dimensional boundary layers due to streamline curvature
[HTN-95-61070] p 430 A95-83654

GOES SATELLITES

- Flight Mechanics/Estimation Theory Symposium 1995
[NASA-CP-3299] p 416 N95-27763

GOVERNMENT PROCUREMENT

- Surviving the peace. Lessons learned from the aircraft industry in the 1920s and 1930s
[AD-A288284] p 366 N95-26455

GOVERNMENT/INDUSTRY RELATIONS

- STEP: A future revision, today
[NONP-NASA-VT-95-49121] p 452 N95-27209
Collected papers on wind turbine technology
[NASA-CR-195432] p 447 N95-27970

GRAPHITE-EPOXY COMPOSITES

- Structural modification and repair of C-130 wing structure using bonded composites p 394 N95-27512
Scarf repairs to graphite/epoxy components p 396 N95-27523
Load transfer in the stiffener-to-skin joints of a pressurized fuselage
[NASA-CR-198610] p 439 N95-27865
Investigation of static and cyclic bearing failure mechanisms for GR/EP laminates p 422 N95-28427
Effects of floor location on response of composite fuselage frames p 423 N95-28439
Structural testing of the technology integration box beam p 441 N95-28467
Effect of low-speed impact damage and damage location on behavior of composite panels p 426 N95-28481
Compressive strength of damaged and repaired composite plates p 442 N95-28484

GRAPHITE-POLYIMIDE COMPOSITES

Fundamental concepts in the suppression of delamination buckling by stitching p 426 N95-28486
 NASA-ACEE/Boeing 737 graphite-epoxy horizontal stabilizer service p 400 N95-28489

GRAPHITE-POLYIMIDE COMPOSITES

R & D on HOPE structure p 413 A95-82355

GRAPHS (CHARTS)

Naval Aviation System TEAM mapping, charting, and geodesy handbook [AD-A288590] p 446 N95-26841

GRAY GAS

Contribution of thermal radiation to the temperature profile of ceramic composite materials [BTN-94-EIX95011441252] p 417 A95-84209

GREENLAND

An overview of millimeter-wave spectroscopic measurements of chlorine monoxide at Thule, Greenland, February-March, 1992: Vertical profiles, diurnal variation, and longer-term trends [HTN-95-00722] p 444 A95-86292

GRID GENERATION (MATHEMATICS)

Computational/experimental investigation of staged injection into a Mach 2 flow [HTN-95-51646] p 432 A95-85028

Practical formulation of a positively conservative scheme [HTN-95-51668] p 433 A95-85050

Supersonic transport grid generation, validation, and optimization [NASA-CR-197752] p 448 N95-26648

Numerical simulation of the flow about the F-18 HARV at high angle of attack [NASA-CR-197755] p 374 N95-26735

Computational support of the laminar flow supersonic wind tunnel, CNSFV code development, Maglev, and grid generation [NASA-CR-197750] p 411 N95-26775

Global flowfield about the V-22 Tiltrotor Aircraft [NASA-CR-198603] p 375 N95-27248

Calculation of three-dimensional (3-D) internal flow by means of the velocity-vorticity formulation on a staggered grid [NASA-TM-110352] p 376 N95-27258

TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document [NASA-CR-4348] p 378 N95-28265

GROOVES

Wind-tunnel tests of an inclined cylinder having helical grooves [BTN-95-EIX95262694306] p 411 A95-85477

GROUND BASED CONTROL

Air traffic operational inventory CY 1994 [AD-A288281] p 382 N95-26454

GROUND CREWS

Pilot rating scale for aircraft handling qualities [HTN-95-42269] p 380 A95-84963

GROUND EFFECT (AERODYNAMICS)

Direct boundary integral equations method to subsonic flow with circulation past thin airfoils in ground effect [BTN-95-EIX95242673940] p 365 A95-82224

Experimental investigation of static and dynamic ground effect on HOPE ALFLEX vehicle [NAL-TR-1236] p 388 N95-26525

GROUND EFFECT MACHINES

Air cushioned landing craft (LCAC) based ship to shore movement simulation: A decision aid for the amphibious commander. A (SMMAT) application [AD-A289635] p 436 N95-26722

GUST LOADS

Calculation of design load for the MOD-5A 7.3 mW wind turbine system p 440 N95-27982

Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system p 440 N95-27983

GUSTS

Calculation of design load for the MOD-5A 7.3 mW wind turbine system p 440 N95-27982

H

HAMILTONIAN FUNCTIONS

Aeroelasticity and structural optimization of composite helicopter rotor blades with swept tips [NASA-CR-4665] p 397 N95-28262

HANDBOOKS

Naval Aviation System TEAM mapping, charting, and geodesy handbook [AD-A288590] p 446 N95-26841

HARMONIC CONTROL

A higher harmonic control test in the DNW to reduce impulsive BVI noise [HTN-95-61071] p 385 A95-83655

HARMONIC MOTION

Subharmonic and quasi-periodic motions of an eccentric squeeze film damper-mounted rigid rotor [BTN-94-EIX95011440601] p 429 A95-82982

HARMONICS

On the influence of time-varying flow velocity on unsteady aerodynamics [HTN-95-61073] p 369 A95-83657

HARNESSES

Partial discharge testing of high voltage wiring harness for airborne displays [AD-A289150] p 401 N95-27003

HARRIER AIRCRAFT

Navy composite maintenance and repair experience p 424 N95-28446

HAZARDS

The effect of aviation fuels containing low amounts of static dissipater additive on electrostatic charge generation [AD-A280075] p 420 N95-28152

HEAD-UP DISPLAYS

Simulation model of the integrated flight/propulsion control system, displays, and propulsion system for ASTOVL lift-fan aircraft [NASA-TM-108866] p 405 N95-26412

HEAT EXCHANGERS

Mechanism of deposit formation on fuel-wetted hot metal surfaces [AD-A289847] p 426 N95-28621

HEAT FLUX

Experiment and analysis on heat transfer of a scramjet leading edge model p 403 A95-82420

Free convection past a uniform flux surface inclined at a small angle to the horizontal [HTN-95-42213] p 430 A95-84029

Contribution of thermal radiation to the temperature profile of ceramic composite materials [BTN-94-EIX95011441252] p 417 A95-84209

Constant flux, turbulent convection data using infrared imaging [HTN-95-20731] p 435 A95-86621

HEAT PIPES

Experimental investigation of composite channel heat pipe operation in micro-gravity environment p 428 A95-82645

HEAT PUMPS

Second-law analysis of vapor compression heat pumps with solution circuit [BTN-94-EIX95011441236] p 431 A95-84193

HEAT RESISTANT ALLOYS

Study on the turbine vane and blade for a 1500 C class industrial gas turbine [BTN-94-EIX95011441254] p 431 A95-84211

The potential for CMCs to replace superalloys in engine exhaust ducts [HTN-95-42298] p 418 A95-84992

HEAT TRANSFER

Experiment and analysis on heat transfer of a scramjet leading edge model p 403 A95-82420

Experimental investigation of composite channel heat pipe operation in micro-gravity environment p 428 A95-82645

Convection heat transfer distributions over plates with square ribs from infrared thermography measurements [HTN-95-20713] p 435 A95-86603

WINCLR: A computer code for heat transfer and clearance calculation in a compressor [NASA-CR-195436] p 366 N95-26363

HEATING EQUIPMENT

Second-law analysis of vapor compression heat pumps with solution circuit [BTN-94-EIX95011441236] p 431 A95-84193

HELICOPTER CONTROL

Neuro-controllers for adaptive helicopter training [SAE PAPER 932535] p 379 A95-84557

Automated hover training: An empirical evaluation [SAE PAPER 932536] p 379 A95-84559

Torsional actuation with extension-torsion composite coupling and a magnetostrictive actuator [BTN-95-EIX95262694314] p 435 A95-85485

An investigation of the effects of pitch-roll (de)coupling on helicopter handling qualities [NASA-TM-110349] p 409 N95-26773

HELICOPTER DESIGN

Construction and wind tunnel test of a 1/12th scale helicopter model [AD-A288487] p 378 N95-28331

Modeling helicopter blade dynamics using a modified Myklestad-Prohl transfer matrix method [AD-A289891] p 400 N95-28626

HELICOPTER PERFORMANCE

Condition monitoring and diagnostics [HTN-95-92312] p 387 A95-85356

An investigation of the effects of pitch-roll (de)coupling on helicopter handling qualities [NASA-TM-110349] p 409 N95-26773

HELICOPTER WAKES

Vortex methods for the computational analysis of rotor/body interaction [HTN-95-61072] p 369 A95-83656

Considerations in the development of the coupled rotor fuselage model [HTN-95-61077] p 370 A95-83661

An experimental investigation of helicopter downwash and tailboom interaction at the Wichita State University 7x10 foot wind tunnel p 375 N95-26955

HELICOPTERS

A higher harmonic control test in the DNW to reduce impulsive BVI noise [HTN-95-61071] p 385 A95-83655

Vortex methods for the computational analysis of rotor/body interaction [HTN-95-61072] p 369 A95-83656

Effects of blade tip shape on dynamics, cost, weight, aerodynamic performance, and aeroelastic response [HTN-95-61074] p 369 A95-83658

Air resonance of hingeless rotor helicopters in trimmed forward flight [HTN-95-61075] p 369 A95-83659

An analytical model for a nonlinear elastomeric lag damper and its effect on aeromechanical stability in Hover [HTN-95-61076] p 369 A95-83660

Considerations in the development of the coupled rotor fuselage model [HTN-95-61077] p 370 A95-83661

Artificial neural networks for predicting nonlinear dynamic helicopter loads [HTN-95-51678] p 404 A95-85060

Reduction of blade-vortex interaction noise through porous leading edge [HTN-95-42324] p 371 A95-86153

Aircraft noise prediction program theoretical manual: Rotorcraft System Noise Prediction System (ROTONET), part 4 [NASA-TM-83199-PT-4] p 451 N95-26392

An investigation of the effects of pitch-roll (de)coupling on helicopter handling qualities [NASA-TM-110349] p 409 N95-26773

Flow structure generated by perpendicular blade vortex interaction and implications for helicopter noise predictions [NASA-CR-198590] p 377 N95-28193

Aeroelasticity and structural optimization of composite helicopter rotor blades with swept tips [NASA-CR-4665] p 397 N95-28262

Construction and wind tunnel test of a 1/12th scale helicopter model [AD-A288487] p 378 N95-28331

Modeling helicopter blade dynamics using a modified Myklestad-Prohl transfer matrix method [AD-A289891] p 400 N95-28626

Rotorcraft crashworthy airframe and fuel system technology development program [AD-A289986] p 382 N95-28630

HELIUM

Flowfield measurements in supersonic film cooling including the effect of shock-wave interaction [HTN-95-42337] p 405 A95-86166

HELMET MOUNTED DISPLAYS

Partial discharge testing of high voltage wiring harness for airborne displays [AD-A289150] p 401 N95-27003

HETEROGENEITY

Evolution of the concentrations of trace species in an aircraft plume: Trajectory study [HTN-95-A1044] p 443 A95-84549

The effect of material heterogeneity in curved composite beams for use in aircraft structures p 422 N95-28426

HIGH ALTITUDE

Design of a high altitude long endurance aircraft with manufacturing considerations p 391 N95-26947

Propulsion system assessment for very high UAV under ERAST [NASA-CR-195469] p 406 N95-27866

HIGH ALTITUDE BALLOONS

Development and flight results of fiber reinforced balloon p 384 A95-82511

Recent developments in nylon superpressure balloons p 385 A95-82512

Polar Patrol Balloon system and preliminary experimental results p 368 A95-82513

Study on a scheme for the prolongation of microgravity time of balloon-borne drop capsule p 414 A95-82515

Variational principles for ascent shapes of large scientific balloons [BTN-95-EIX95262694320] p 387 A95-85491

HIGH FREQUENCIES

Design and development of a test rig for the high frequency testing of rolling sleeve airsprings [DSTO-TN-0001] p 411 N95-26378

HIGH GRAVITY ENVIRONMENTS

The large radius track centrifuge concept as an acceleration research and simulation device
p 379 A95-84560

HIGH PRESSURE

Thermo-hydrodynamic solution of floating ring seals for high pressure compressors using the finite-element method
[HTN-95-92246] p 433 A95-85290

An investigation of the AFIT 2-inch shock tube as a flow source for supersonic testing
[AD-A289246] p 412 N95-26966

NASA Lewis Research Center's combustor test facilities and capabilities
[NASA-TM-106903] p 412 N95-27176

HIGH RESOLUTION

Classification of ultra high range resolution radar using decision boundary analysis
[AD-A289378] p 437 N95-26877

HIGH REYNOLDS NUMBER

Comparative wind tunnel test at high Reynolds numbers of NACA 64 621 airfoils with two aileron configurations
p 377 N95-27977

HIGH SPEED

Application of CFD to the analysis and design of high-speed inlets
[NASA-CR-198574] p 438 N95-27240

HIGH STRENGTH

Repairs of CFC primary structures
p 396 N95-27527

HIGH STRENGTH ALLOYS

Forming and bonding techniques for high-strength aluminum alloys
[HTN-95-20605] p 418 A95-84786

HIGH TEMPERATURE ENVIRONMENTS

The potential for CMCs to replace superalloys in engine exhaust ducts
[HTN-95-42298] p 418 A95-84992

HIGH TEMPERATURE TESTS

Contribution of thermal radiation to the temperature profile of ceramic composite materials
[BTN-94-EIX95011441252] p 417 A95-84209

Study on the turbine vane and blade for a 1500 C class industrial gas turbine
[BTN-94-EIX95011441254] p 431 A95-84211

HIGH VOLTAGES

Partial discharge testing of high voltage wiring harness for airborne displays
[AD-A289150] p 401 N95-27003

HISTORIES

Application of CFD to the analysis and design of high-speed inlets
[NASA-CR-198574] p 438 N95-27240

HONEYCOMB STRUCTURES

Field repair materials for naval aircraft
p 394 N95-27514

Composite repair of a CF18: Vertical stabilizer leading edge
p 395 N95-27517

Composite repair issues on the CF-18 aircraft
p 395 N95-27518

External patch repair of CFRP/honeycomb sandwich
p 395 N95-27522

Scarf repairs to graphite/epoxy components
p 396 N95-27523

HORIZONTAL FLIGHT

Air resonance of hingeless rotor helicopters in trimmed forward flight
[HTN-95-61075] p 369 A95-83659

HORIZONTAL ORIENTATION

Horizontal axis wind turbine post stall airfoil characteristics synthesis
p 376 N95-27974

A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines
p 439 N95-27980

Measurement and prediction of broadband noise from large horizontal axis wind turbine generators
p 451 N95-27990

HOT SURFACES

Mechanism of deposit formation on fuel-wetted hot metal surfaces
[AD-A289847] p 426 N95-28621

HOT-WIRE ANEMOMETERS

A review of the hot-wire technique in 2-D compressible flow
[HTN-95-61157] p 373 A95-86256

HOVERING

Neuro-controllers for adaptive helicopter training
[SAE PAPER 932535] p 379 A95-84557

Intelligent flight trainer for initial rotary wing training
[SAE PAPER 932536] p 386 A95-84558

Automated hover training: An empirical evaluation
[SAE PAPER 932536] p 379 A95-84559

An experimental investigation of helicopter downwash and tailboom interaction at the Wichita State University 7x10 foot wind tunnel
p 375 N95-26955

HOVERING STABILITY

An analytical model for a nonlinear elastomeric lag damper and its effect on aeromechanical stability in Hover
[HTN-95-61076] p 369 A95-83660

HUBS

Effects of blade tip shape on dynamics, cost, weight, aerodynamic performance, and aeroelastic response
[HTN-95-61074] p 369 A95-83658

Considerations in the development of the coupled rotor fuselage model
[HTN-95-61077] p 370 A95-83661

HUMAN CENTRIFUGES

The large radius track centrifuge concept as an acceleration research and simulation device
p 379 A95-84560

HUMAN FACTORS ENGINEERING

Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993
[SAE SP-992] p 417 A95-84553

Human factors issues in aircraft cabin design
[SAE PAPER 932527] p 386 A95-84556

Digital systems validation. Chapter 20 Artificial Intelligence with applications for aircraft. Handbook, volume 2
[AD-A288492] p 448 N95-26638

Integrated mission precision attack cockpit technology (IMPACT). Phase 1: Identifying technologies for air-to-ground fighter integration
[AD-A289562] p 389 N95-26684

HYBRID NAVIGATION SYSTEMS

Fight evaluation of DGPS and DGPS-INS navigation systems
p 382 A95-82462

HYDRAULIC EQUIPMENT

Composite flight-control actuator development
p 410 N95-28281

HYDRAULIC TEST TUNNELS

Demonstration study of hierarchical control of fluid-dynamic phenomena
[AD-A289341] p 437 N95-26751

HYDRODYNAMICS

Thermo-hydrodynamic solution of floating ring seals for high pressure compressors using the finite-element method
[HTN-95-92246] p 433 A95-85290

HYDROGEN

Ignition analysis of hydrogen/air mixture in supersonic mixing layer
p 416 A95-82301

General solution procedure for flows in local chemical equilibrium
[HTN-95-42329] p 404 A95-86158

Stationary premixed flames in spherical and cylindrical geometries
[HTN-95-42336] p 418 A95-86165

A hybrid vehicle evaluation code and its application to vehicle design. Revision 1
[DE95-008053] p 441 N95-28029

HYDROGEN CHLORIDES

Aircraft measurements of CLO and HCL during EASOE 1991/92
[HTN-95-00721] p 444 A95-86291

HYDROGEN ENGINES

A hybrid vehicle evaluation code and its application to vehicle design. Revision 1
[DE95-008053] p 441 N95-28029

A hybrid vehicle evaluation code and its application to vehicle design, revision 2
[DE95-008060] p 441 N95-28139

HYDROGEN FUELS

Studies on plasma jet igniters
p 403 A95-82680

HYDROSTATICS

Electro-hydrostatic actuator controller design using quantitative feedback theory
[AD-A289220] p 409 N95-26957

HYDROXYL RADICALS

A model for temperature-dependent collisional quenching of OH A(sup 2) Sigma(sup +)
[HTN-95-42308] p 450 A95-85002

HYPERCUBE MULTIPROCESSORS

A fixed time performance evaluation of parallel CFD applications
[DE94-014240] p 436 N95-26445

HYPERSONIC AIRCRAFT

An advanced scramjet propulsion concept for A 350 MG SSTO space plane
p 402 A95-82325

A conceptual design of hypersonic research vehicle with subscale scramjet engine
p 384 A95-82482

Optimal trajectories for hypersonic launch vehicles
[HTN-95-61120] p 415 A95-84884

HYPERSONIC FLIGHT

Hypersonic trajectory control of aerospace plane with integrated SCRAMJET engine
p 413 A95-82384

Hypersonic thermal protection with mass injection at angle of attack
p 414 A95-82414

HYPERSONIC FLOW

VSL analysis of hypersonic flows around a reentry vehicle with equilibrium air chemistry
p 413 A95-82400

Reentry technology experiment on the first mission of reentry capsule 'EXPRESS'
p 414 A95-82499

Hypersonic flow simulation with thermoelectric effect
p 368 A95-82669

Accuracy and efficiency assessments for a weak statement CFD algorithm for high-speed aerodynamics
[BTN-94-EIX95011441238] p 370 A95-84195

Viscous shock-layer analysis on hypersonic flow over reentry capsule with nonequilibrium chemistry
[ISAS-656] p 436 N95-26739

HYPERSONIC REENTRY

VSL analysis of hypersonic flows around a reentry vehicle with equilibrium air chemistry
p 413 A95-82400

Atmospheric reentry flight test of winged space vehicle
p 414 A95-82483

Viscous shock-layer analysis on hypersonic flow over reentry capsule with nonequilibrium chemistry
[ISAS-656] p 436 N95-26739

HYPERSONIC SPEED

Application of CFD to the analysis and design of high-speed inlets
[NASA-CR-198574] p 438 N95-27240

HYPERSONIC VEHICLES

A concept of a hypersonic flight experiment of a winged vehicle
p 414 A95-82477

HYPERSONIC WIND TUNNELS

Design features of the NAL ramjet engine test facility
p 410 A95-82319

Hypersonic wind tunnel test of sidewall compression type scramjet inlet
p 410 A95-82320

An experimental investigation of scramjet nozzle flow
p 402 A95-82322

HYPERVELOCITY PROJECTILES

An experimental study on radiation from strong shock layer
p 368 A95-82421

ICE

Analysis of aircraft engine blade subject to ice impact
p 407 N95-28277

ICE CLOUDS

Replicator for characterization of cirrus and polar stratospheric cloud particles
[NASA-CR-197785] p 445 N95-26669

ICE FORMATION

Replicator for characterization of cirrus and polar stratospheric cloud particles
[NASA-CR-197785] p 445 N95-26669

Further investigations of icing effects on an advanced high-lift multi-element airfoil
[NASA-TM-106947] p 381 N95-27762

IDEAL GAS

General solution procedure for flows in local chemical equilibrium
[HTN-95-42329] p 404 A95-86158

IDENTIFYING

The use of electrochemistry and ellipsometry for identifying and evaluating corrosion on aircraft
[AD-A288536] p 381 N95-27186

IGNITION

Ignition analysis of hydrogen/air mixture in supersonic mixing layer
p 416 A95-82301

Studies on plasma jet igniters
p 403 A95-82680

Effects of dust from storage heaters on ignition in scramjets
[NAL-TR-1234] p 405 N95-26706

IMAGING TECHNIQUES

Time-domain imaging of airborne targets using ultra-wideband or short-pulse radar
[BTN-95-EIX95242673673] p 450 A95-82251

Mapping of forest fire damages using imaging spectroscopy
p 442 A95-83627

Replicator for characterization of cirrus and polar stratospheric cloud particles
[NASA-CR-197785] p 445 N95-26669

IMPACT DAMAGE

Non-linear analysis provides new insights into impact damage of composite structures
[HTN-95-42368] p 418 A95-86197

Analysis of aircraft engine blade subject to ice impact
p 407 N95-28277

Effect of low-speed impact damage and damage location on behavior of composite panels
p 426 N95-28481

Impact damage resistance of composite fuselage structure, part 1
p 399 N95-28482

Applications of a damage tolerance analysis methodology in aircraft design and production
p 426 N95-28483

Compressive strength of damaged and repaired composite plates p 442 N95-28484
Fundamental concepts in the suppression of delamination buckling by stitching p 426 N95-28486
Damage tolerance of a geodesically stiffened advanced composite structural concept for aircraft structural applications p 399 N95-28487
Advanced wing design survivability testing and results p 400 N95-28488

IMPACT LOADS

Effects of floor location on response of composite fuselage frames p 423 N95-28439

IMPACT STRENGTH

Effects of floor location on response of composite fuselage frames p 423 N95-28439

IMPACT TESTS

Development of repair processes and sources for C/KC-135 aircraft windows/windshields [AD-A288348] p 367 N95-26629
Analysis of aircraft engine blade subject to ice impact p 407 N95-28277

Effect of low-speed impact damage and damage location on behavior of composite panels p 426 N95-28481

Impact damage resistance of composite fuselage structure, part 1 p 399 N95-28482

Applications of a damage tolerance analysis methodology in aircraft design and production p 426 N95-28483
Damage tolerance of a geodesically stiffened advanced composite structural concept for aircraft structural applications p 399 N95-28487
Rotorcraft crashworthy airframe and fuel system technology development program [AD-A289886] p 382 N95-28630

Through-the Thickness(R) braided composites for aircraft applications p 421 N95-28273

A higher harmonic control test in the DNW to reduce impulsive BVI noise [HTN-95-61071] p 385 A95-83655

Replicator for characterization of cirrus and polar stratospheric cloud particles [NASA-CR-197785] p 445 N95-26669

Condition monitoring and diagnostics [HTN-95-92312] p 387 A95-85356

Direct boundary integral equations method to subsonic flow with circulation past thin airfoils in ground effect [BTN-95-EIX95242673940] p 365 A95-82224

On the influence of time-varying flow velocity on unsteady aerodynamics [HTN-95-61073] p 369 A95-83657

Predicting stall and post-stall behavior of airfoils at low mach numbers [BTN-95-EIX95262694297] p 365 A95-85468

Prediction of two-dimensional momentumless wake by k-epsilon - gamma model [BTN-95-EIX95262694299] p 434 A95-85470

CFD research, parallel computation and aerodynamic optimization [NASA-CR-197748] p 373 N95-26649

Probabilistic material strength degradation model for Inconel 718 components subjected to high temperature, high-cycle and low-cycle mechanical fatigue, creep and thermal fatigue effects [NASA-CR-197832] p 419 N95-27167

The effects of surface modification on fretting fatigue in Ti alloy turbine components [HTN-95-61145] p 404 A95-84909

Aeronautical engineering: A continuing bibliography with indexes (supplement 318) [NASA-SP-7037(318)] p 367 N95-27543

Asian Aeronautics: Technology acquisition drives industry development. Report to Congressional requesters [GAO/NSIAD-94-140] p 367 N95-26817

Electro-hydrostatic actuator controller design using quantitative feedback theory [AD-A289220] p 409 N95-26957

Rarefied gas numerical wind tunnel: OREX and HOPE p 427 A95-82391

Flight evaluation of DGPS and DGPS-INS navigation systems p 382 A95-82462

Constant flux, turbulent convection data using infrared imaging [HTN-95-20731] p 435 A95-86621

A computer code for heat transfer and clearance calculation in a compressor [NASA-CR-195436] p 366 N95-26363

Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics [NASA-TM-106685] p 416 N95-27434

Permanent magnet electron cyclotron resonance plasma source with remote window [BTN-95-EIX95242674338] p 450 A95-82176

Quantitative investigation of compressible mixing: Staged transverse injection into Mach 2 flow [HTN-95-42330] p 404 A95-86159

Experiment on a rectangular cross section scramjet combustor. 2: Effects of fuel injector geometry [NAL-TR-1220] p 405 N95-26600

Performance study for inlet installations [NASA-CR-189714] p 406 N95-28227

Numerical investigation to S-inlet flows (Numerical simulation study of S-inlet flows) [AD-A289590] p 374 N95-26713

Characteristics of the turbine inlet temperature sensing circuit for the T56 turbo-prop engine [DSTO-TR-0095] p 405 N95-26424

Maintenance programs [HTN-95-92310] p 365 A95-85354

Fibre-Metal laminates p 387 A95-85895

Elements of structural integrity assurance p 387 A95-85896

Verification of the damage tolerance of a fighter aircraft p 388 A95-85897

Damage tolerance capability p 388 A95-85898

Characterization of corrosion and development of a breadboard of a D sight aircraft inspection system, phase 1 [AD-A288347] p 380 N95-26527

Flight evaluation of GPS/DGPS sensor systems installed in NAL Do228 [NAL-TR-1230] p 382 N95-26585

An integrated GPS/INS/BARO and radar altimeter system for aircraft precision approach landings [AD-A289280] p 383 N95-26985

Direct boundary integral equations method to subsonic flow with circulation past thin airfoils in ground effect [BTN-95-EIX95242673940] p 365 A95-82224

An inverse design method of transonic airfoil and wing [HTN-95-71128] p 385 A95-83489

Interaction of jet noise with a nearby panel assembly [BTN-95-EIX95262694295] p 434 A95-85466

Design and structural validation of CF116 upper wing skin boron doubler p 393 N95-27510

Interferometric investigations of compressible dynamic stall over a transiently pitching airfoil [HTN-95-42338] p 372 A95-86167

A hybrid vehicle evaluation code and its application to vehicle design. Revision 1 [DE95-008053] p 441 N95-28029

A hybrid vehicle evaluation code and its application to vehicle design, revision 2 [DE95-008060] p 441 N95-28139

A fixed time performance evaluation of parallel CFD applications [DE94-014240] p 436 N95-26445

Calculation of three-dimensional (3-D) internal flow by means of the velocity-vorticity formulation on a staggered grid [NASA-TM-110352] p 376 N95-27258

Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics [NASA-TM-106685] p 416 N95-27434

Composite fuselage shell structures research at NASA Langley Research Center p 425 N95-28466

International cooperation in standardization p 452 A95-82665

High-stakes aviation: US-Japan technology linkages in transport aircraft [LC-94-65759] p 381 N95-27907

JTEC/WTEC annual report and program summary: 1993/94 [NASA-CR-198563] p 454 N95-28038

Charles Norvin Rineck: an early American pioneer in advanced aviation engines [SAE PAPER 930485] p 386 A95-84554

Time-domain imaging of airborne targets using ultra-wideband or short-pulse radar [BTN-95-EIX95242673673] p 450 A95-82251

Dynamic unstructured method for flows past multiple objects in relative motion [BTN-95-EIX95262694303] p 435 A95-85474

Compressible inviscid vortex flow of a sharp edge delta wing [BTN-95-EIX95262694308] p 370 A95-85479

General solution procedure for flows in local chemical equilibrium [HTN-95-42329] p 404 A95-86158

A fixed time performance evaluation of parallel CFD applications [DE94-014240] p 436 N95-26445

Radiation safety aspects of commercial high-speed flight transportation [NASA-TP-3524] p 453 N95-26427

Experimental investigation of inlet-combustor isolators for a dual-mode scramjet at a Mach number of 4 [NASA-TP-3502] p 407 N95-28343

An easy way to analyze longitudinal and lateral-directional trim problems with AEO or OEI p 409 N95-26949

Analysis and simulation of narrowband GPS jamming using digital excision temporal filtering [AD-A289328] p 383 N95-26898

High-stakes aviation: US-Japan technology linkages in transport aircraft [LC-94-65759] p 381 N95-27907

JTEC/WTEC annual report and program summary: 1993/94 [NASA-CR-198563] p 454 N95-28038

Verification of the damage tolerance of a fighter aircraft p 388 A95-85897

Aircraft gas turbine emissions challenge [BTN-94-EIX95011441239] p 403 A95-84196

Aircraft IR/acoustic detection evaluation. Volume 2: Development of a ground-based acoustic sensor system for the detection of subsonic jet-powered aircraft [NASA-CR-189705-VOL-2] p 452 N95-28073

Structure of supersonic jet flow and its radiated sound [HTN-95-51645] p 431 A95-85027

Screech tones from free and ducted supersonic jets [HTN-95-51647] p 432 A95-85029

Interaction of jet noise with a nearby panel assembly [BTN-95-EIX95262694295] p 434 A95-85466

Supersonic coaxial jet noise predictions [NASA-TM-106917] p 451 N95-26801

Preliminary results and research capabilities of a new jet facility at the University of Kansas p 412 N95-26951

Basic studies in turbulent shear flows [AD-A289145] p 437 N95-26998

A numerical study of fundamental shock noise mechanisms [NASA-TM-110608] p 451 N95-27908

Response of multi-panel assembly to noise from a jet in forward motion [NASA-CR-198164] p 442 N95-28673

Mechanism of deposit formation on fuel-wetted hot metal surfaces [AD-A289847] p 426 N95-28621

Hybrid finite element-modal analysis of jet engine inlet scattering [BTN-95-EIX95242673665] p 427 A95-82259

Performance characterization of a highly-offset diffuser with and without blowing vortex generator jets [AD-A289334] p 375 N95-26901

J

JAMMING

Analysis and simulation of narrowband GPS jamming using digital excision temporal filtering [AD-A289328] p 383 N95-26898

JAPAN

High-stakes aviation: US-Japan technology linkages in transport aircraft [LC-94-65759] p 381 N95-27907

JTEC/WTEC annual report and program summary: 1993/94 [NASA-CR-198563] p 454 N95-28038

JAS-39 AIRCRAFT

Verification of the damage tolerance of a fighter aircraft p 388 A95-85897

JET AIRCRAFT

Aircraft gas turbine emissions challenge [BTN-94-EIX95011441239] p 403 A95-84196

Aircraft IR/acoustic detection evaluation. Volume 2: Development of a ground-based acoustic sensor system for the detection of subsonic jet-powered aircraft [NASA-CR-189705-VOL-2] p 452 N95-28073

JET AIRCRAFT NOISE

Structure of supersonic jet flow and its radiated sound [HTN-95-51645] p 431 A95-85027

Screech tones from free and ducted supersonic jets [HTN-95-51647] p 432 A95-85029

Interaction of jet noise with a nearby panel assembly [BTN-95-EIX95262694295] p 434 A95-85466

Supersonic coaxial jet noise predictions [NASA-TM-106917] p 451 N95-26801

Preliminary results and research capabilities of a new jet facility at the University of Kansas p 412 N95-26951

Basic studies in turbulent shear flows [AD-A289145] p 437 N95-26998

A numerical study of fundamental shock noise mechanisms [NASA-TM-110608] p 451 N95-27908

Response of multi-panel assembly to noise from a jet in forward motion [NASA-CR-198164] p 442 N95-28673

JET ENGINE FUELS

Mechanism of deposit formation on fuel-wetted hot metal surfaces [AD-A289847] p 426 N95-28621

JET ENGINES

Hybrid finite element-modal analysis of jet engine inlet scattering [BTN-95-EIX95242673665] p 427 A95-82259

Performance characterization of a highly-offset diffuser with and without blowing vortex generator jets [AD-A289334] p 375 N95-26901

Preliminary results and research capabilities of a new jet facility at the University of Kansas

p 412 N95-26951

JET FLOW

Numerical investigation of cylinder wake flow with a rear stagnation jet

[HTN-95-51669] p 433 A95-85051

Interaction of jet noise with a nearby panel assembly

[BTN-95-EIX95262694295] p 434 A95-85466

Prediction of two-dimensional momentumless wake by k-epsilon-gamma model

[BTN-95-EIX95262694299] p 434 A95-85470

Mixing enhancement by and noise characteristics of streamwise vortices in an air jet

[HTN-95-42322] p 371 A95-86151

The noise reduction potential of dual-stream coaxial rectangular improperly expanded jet flows

[NASA-CR-197820] p 437 N95-26995

Response of multi-panel assembly to noise from a jet in forward motion

[NASA-CR-198164] p 442 N95-28673

JET MIXING FLOW

Mixing enhancement by and noise characteristics of streamwise vortices in an air jet

[HTN-95-42330] p 371 A95-86151

Quantitative investigation of compressible mixing: Staged transverse injection into Mach 2 flow

[HTN-95-42330] p 404 A95-86159

JET NOZZLES

Visualization of the multiple supersonic jet oscillations by swept focused strobed schlieren technique

p 367 N95-26952

JET VANES

Study on the turbine vane and blade for a 1500 C class industrial gas turbine

[BTN-94-EIX95011441254] p 431 A95-84211

JETTISONING

A numerical model to predict the fate of jettisoned aviation fuel

[AD-A289336] p 419 N95-26842

JOINTS (JUNCTIONS)

Analysis of backscattering from wing and fuselage joints

[HTN-95-71134] p 430 A95-83495

Status of bonded boron/epoxy doublers for military and commercial aircraft structures

p 393 N95-27506

Load transfer in the stiffener-to-skin joints of a pressurized fuselage

[NASA-CR-198610] p 439 N95-27865

JOURNAL BEARINGS

The dynamic nature of rotor thermal bending due to unsteady lubricant shearing within a bearing

[HTN-95-42091] p 430 A95-83857

Effect of squeeze film damper land geometry on damper performance

[HTN-95-92247] p 434 A95-85291

K

K-EPSILON TURBULENCE MODEL

Prediction of two-dimensional momentumless wake by k-epsilon-gamma model

[BTN-95-EIX95262694299] p 434 A95-85470

KEVLAR (TRADEMARK)

Utilization of composite materials by the US Army: A look ahead

p 421 N95-28421

KNOWLEDGE BASED SYSTEMS

New tools for creating instruction and simulations

[SAE PAPER 932600] p 380 A95-84572

KNOWLEDGE BASES (ARTIFICIAL INTELLIGENCE)

Digital systems validation. Chapter 20 Artificial intelligence with applications for aircraft. Handbook, volume 2

[AD-A288492] p 448 N95-26638

KOLMOGOROV THEORY

Sphere wakes at moderate Reynolds numbers in a turbulent environment

[HTN-95-42331] p 372 A95-86160

KUTTA-JOUKOWSKI CONDITION

Explicit Kutta condition for an unsteady two-dimensional constant potential panel method

[HTN-95-51679] p 433 A95-85061

L

LABORATORY EQUIPMENT

A laboratory scale supersonic combustive flow system

[DE95-006347] p 420 N95-27851

LAMINAR BOUNDARY LAYER

Quiet-flow Ludwig tube for high-speed transition research

[BTN-95-EIX95262694309] p 370 A95-85480

LAMINAR FLOW

Measurements of vortex pair interaction with a clean or contaminated free surface

[BTN-94-EIX95011441063] p 429 A95-82798

Quiet-flow Ludwig tube for high-speed transition research

[BTN-95-EIX95262694309] p 370 A95-85480

Computational support of the laminar flow supersonic wind tunnel, CNSFV code development, Maglev, and grid generation

[NASA-CR-197750] p 411 N95-26775

LAMINAR MIXING

Ignition analysis of hydrogen/air mixture in supersonic mixing layer

[HTN-95-42340] p 416 A95-82301

LAMINATES

Fatigue of aircraft materials; Specialists' Conference, Delft, Netherlands, 1992

[HTN-95-80076] p 387 A95-85892

Fatigue of aircraft materials and structures

p 387 A95-85894

Fibre-Metal laminates

p 387 A95-85895

Active plate and missile wing development using directionally attached piezoelectric elements

[HTN-95-42340] p 408 A95-86169

Scarf repairs to graphite/epoxy components

p 396 N95-27523

Scarf joint technique with cocured and precured patches for composite repair

p 396 N95-27524

Analysis of aircraft engine blade subject to ice impact

p 407 N95-28277

Investigation of static and cyclic bearing failure mechanisms for GR/EP laminates

p 422 N95-28427

Probabilistic evaluation of fuselage-type composite structures

p 398 N95-28444

Development of stitched/RTM composite primary structures

p 425 N95-28469

Tension fracture of laminates for transport fuselage. Part 1: Material screening

p 398 N95-28471

Effect of low-speed impact damage and damage location on behavior of composite panels

p 426 N95-28481

Impact damage resistance of composite fuselage structure, part 1

p 399 N95-28482

Applications of a damage tolerance analysis methodology in aircraft design and production

p 426 N95-28483

Fundamental concepts in the suppression of delamination buckling by stitching

p 426 N95-28486

LANDING

Full span flaperons for a biplane

p 391 N95-26954

LANDING AIDS

Precision landing system mathematical modeling study report for Andrews Air Force Base, runway 19L, Camp Springs, MD

[AD-A289015] p 384 N95-27903

LANDING GEAR

Aircraft nosewheel steering simulation

p 412 N95-26944

Rotorcraft crashworthy airframe and fuel system technology development program

[AD-A289986] p 382 N95-28630

LAP JOINTS

Characterization of corrosion and development of a breadboard of a D sight aircraft inspection system, phase 1

[AD-A288347] p 380 N95-26527

LASER APPLICATIONS

Structural design optimization with survivability dependent constraints application: Primary wing box of a multi-role fighter

p 398 N95-28440

LASER DOPPLER VELOCIMETERS

Vibration measurements on rotating machinery using laser Doppler velocimetry

[BTN-94-EIX95011440597] p 429 A95-82986

LATERAL STABILITY

An easy way to analyze longitudinal and lateral-directional trim problems with AEO or OEI

p 409 N95-26949

LAUNCHERS

Permanent magnet electron cyclotron resonance plasma source with remote window

[BTN-95-EIX95242674338] p 450 A95-82176

LAY-UP

Field repair materials for naval aircraft

p 394 N95-27514

Advanced tow placement of composite fuselage structure

p 420 N95-28271

LEADING EDGES

Experiment and analysis on heat transfer of a scramjet leading edge model

p 403 A95-82420

Reduction of blade-vortex interaction noise through porous leading edge

[HTN-95-42324] p 371 A95-86153

Airfoil modification effects on subsonic and transonic pressure distributions and performance for the EA-6B airplane

[NASA-TP-3516] p 373 N95-26382

Composite repair of a CF18: Vertical stabilizer leading edge

p 395 N95-27517

Wind-tunnel test of the S814 thick root airfoil

[DE95-000268] p 376 N95-27541

LEAR JET AIRCRAFT

Aircraft accident report: Controlled collision with Terrain Transportes Aereos Ejecutivos, S.A. (TAESA) Learjet 25D, XA-BBA Dulles International Airport Chantilly, Virginia, June 18, 1994

[NTSB/AAR-95/02] p 380 N95-26498

Two-phase flow research using the learjet apparatus

[NASA-TM-106814] p 438 N95-27854

LEARNING

Intelligent flight trainer for initial rotary wing training

[SAE PAPER 932536] p 386 A95-84558

LEAST SQUARES METHOD

Matrix fraction approach for finite-state aerodynamic modeling

[BTN-95-EIX95262694311] p 365 A95-85482

LIABILITIES

The legal status and liability of the copilot, part 2

[HTN-95-A0578] p 452 A95-83158

LIFE (DURABILITY)

Life evaluation of a low power arcjet thruster

p 403 A95-82337

LIFE CYCLE COSTS

Life cycle costs of alternatives for F-16 printed circuit board diagnosis equipment

[AD-A288744] p 401 N95-28586

LIFE SCIENCES

JPRS report: Science and technology, Central Eurasia

[JPRS-UST-94-022] p 438 N95-27699

LIFT

Wind-tunnel test of the S814 thick root airfoil

[DE95-000268] p 376 N95-27541

Study of potential aerodynamic benefits from spanwise blowing at wingtip

[NASA-TP-3515] p 378 N95-28669

Noise exposure reduction of advanced high-lift systems

[NASA-CR-195077] p 452 N95-28670

LIFT DRAG RATIO

The effect of high lift to drag ratio on aerobraking

p 415 A95-85807

Noise exposure reduction of advanced high-lift systems

[NASA-CR-195077] p 452 N95-28670

LIFT FANS

The lift-fan aircraft: Lessons learned

[NASA-CR-196694] p 392 N95-27143

LIFTING REENTRY VEHICLES

A concept of a hypersonic flight experiment of a winged vehicle

p 414 A95-82477

Atmospheric reentry flight test of winged space vehicle

p 414 A95-82483

LIGHT SCATTERING

Fractal properties of whitecaps

[HTN-95-92121] p 443 A95-83827

LIGHTHILL METHOD

A numerical study of fundamental shock noise mechanisms

[NASA-TM-110608] p 451 N95-27908

LIGHTNING

Aircraft fuel system lightning protection design and qualification test procedures development

[AD-A288401] p 380 N95-26497

LIQUID FUELS

Mechanism of deposit formation on fuel-wetted hot metal surfaces

[AD-A289847] p 426 N95-28621

LIQUID PROPELLANT ROCKET ENGINES

Experiment of rocket-ram annular combustor

p 412 A95-82324

LIQUID-GAS MIXTURES

Two-phase flow research using the learjet apparatus

[NASA-TM-106814] p 438 N95-27854

LOAD DISTRIBUTION (FORCES)

Shear buckling response of tailored composite plates

[HTN-95-51680] p 418 A95-85062

LOAD TESTS

On aircraft repair verification of a fighter A/C integrally stiffened fuselage skin

p 394 N95-27515

Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system

p 440 N95-27983

Development of composite carrythrough bulkhead

p 423 N95-28438

Structural testing of the technology integration box beam

p 441 N95-28467

Technology integration box beam failure study

p 441 N95-28468

LOADS (FORCES)

A comparison of measured wind park load histories with the WISPER and WISPERX load spectra

[DE95-000295] p 446 N95-27459

- Load transfer in the stiffener-to-skin joints of a pressurized fuselage
[NASA-CR-198610] p 439 N95-27865
- A hybrid vehicle evaluation code and its application to vehicle design. Revision 1
[DE95-008053] p 441 N95-28029
- A hybrid vehicle evaluation code and its application to vehicle design, revision 2
[DE95-008060] p 441 N95-28139
- Local design optimization for composite transport fuselage crown panels
p 398 N95-28473
- Comparison of resin film infusion, resin transfer molding, and consolidation of textile preforms for primary aircraft structure
p 425 N95-28477
- LOGISTICS**
- The value of simulation for training
[AD-A289174] p 411 N95-26556
- LONG TERM EFFECTS**
- An overview of millimeter-wave spectroscopic measurements of chlorine monoxide at Thule, Greenland, February-March, 1992: Vertical profiles, diurnal variation, and longer-term trends
[HTN-95-00722] p 444 A95-86292
- LONGITUDINAL CONTROL**
- Robust longitudinal axis flight control for an aircraft with thrust vectoring
[BTN-95-EIX95122538875] p 408 A95-83000
- A comparison of the Neal-Smith and omega Tau function, zeta function and tau function flying qualities criteria
[AD-A289503] p 390 N95-26844
- Use of blade pitch control to provide power train damping for the Mod-2, 2.5-mW wind turbine
p 440 N95-27986
- LONGITUDINAL STABILITY**
- An easy way to analyze longitudinal and lateral-directional trim problems with AEO or OEI
p 409 N95-26949
- LOW COST**
- Design of a high altitude long endurance aircraft with manufacturing considerations
p 391 N95-26947
- Development of a low-cost, modified resin transfer molding process using elastomeric tooling and automated preform fabrication
p 420 N95-28268
- LOW EARTH ORBITS**
- Reentry analysis for low Earth orbiting spacecraft
p 415 A95-85774
- LOW SPEED**
- Effect of low-speed impact damage and damage location on behavior of composite panels
p 426 N95-28481
- Damage tolerance of a geodesically stiffened advanced composite structural concept for aircraft structural applications
p 399 N95-28487
- LUBRICANTS**
- The dynamic nature of rotor thermal bending due to unsteady lubricant shearing within a bearing
[HTN-95-42091] p 430 A95-83857
- LUBRICATION**
- Effect of squeeze film damper land geometry on damper performance
[HTN-95-92247] p 434 A95-85291
- LUNAR ORBITS**
- How 'HITEN's' aerobraking experiments were carried out
p 415 A95-82553
- M**
- MACH NUMBER**
- Predicting stall and post-stall behavior of airfoils at low mach numbers
[BTN-95-EIX95262694297] p 365 A95-85468
- Compressible inviscid vortex flow of a sharp edge delta wing
[BTN-95-EIX95262694308] p 370 A95-85479
- Comparative wind tunnel test at high Reynolds numbers of NACA 64 621 airfoils with two aileron configurations
p 377 N95-27977
- Measurements of store forces and moments and cavity pressures for a generic store in and near a box cavity at subsonic and transonic speeds
[NASA-TM-4611] p 378 N95-28241
- MAGNETIC BEARINGS**
- Whirl plus tilt
[DE95-007948] p 452 N95-28108
- MAGNETIC COILS**
- Extension to the dynamic modeling of the large angle magnetic suspension test fixture
[NASA-CR-197801] p 411 N95-26768
- MAGNETIC LEVITATION VEHICLES**
- Computational support of the laminar flow supersonic wind tunnel, CNSFV code development, Maglev, and grid generation
[NASA-CR-197750] p 411 N95-26775

MAGNETIC SUSPENSION

- Extension to the dynamic modeling of the large angle magnetic suspension test fixture
[NASA-CR-197801] p 411 N95-26768

MAGNETOMETERS

- Flight Mechanics/Estimation Theory Symposium 1995
[NASA-CP-3299] p 416 N95-27763

MAGNETOSTRICTION

- Torsional actuation with extension-torsion composite coupling and a magnetostrictive actuator
[BTN-95-EIX95262694314] p 435 A95-85485

MAINTAINABILITY

- Design of a high altitude long endurance aircraft with manufacturing considerations
p 391 N95-26947
- Report to Congressional Committees. Comanche Helicopter: Testing needs to be completed prior to production decisions
[GAO/NSIAD-95-112] p 397 N95-27910

MAINTENANCE

- Condition monitoring and diagnostics
[HTN-95-92312] p 387 A95-85356
- Life cycle costs of alternatives for F-16 printed circuit board diagnosis equipment
[AD-A288744] p 401 N95-28586

MAINTENANCE TRAINING

- The value of simulation for training
[AD-A289174] p 411 N95-26556

MAN MACHINE SYSTEMS

- Human factors issues in aircraft cabin design
[SAE PAPER 932527] p 386 A95-84556
- Automated hover training: An empirical evaluation
[SAE PAPER 932536] p 379 A95-84559
- Integrated mission precision attack cockpit technology (IMPACT). Phase 1: Identifying technologies for air-to-ground fighter integration
[AD-A289562] p 389 N95-26684
- Survey and implementation of commercial manual controllers for a generic telerobotics architecture
[AD-A289215] p 449 N95-26990

MANAGEMENT PLANNING

- Air traffic operational inventory CY 1994
[AD-A288281] p 382 N95-26454

MANEUVERABILITY

- Airfoil modification effects on subsonic and transonic pressure distributions and performance for the EA-6B airplane
[NASA-TP-3516] p 373 N95-26382

MANEUVERS

- Full span flaperons for a biplane
p 391 N95-26954

MANIPULATORS

- Plate manipulators
[AD-A289601] p 374 N95-26719
- Survey and implementation of commercial manual controllers for a generic telerobotics architecture
[AD-A289215] p 449 N95-26990

MANUFACTURING

- International cooperation in standardization
p 452 A95-82665
- Design of a high altitude long endurance aircraft with manufacturing considerations
p 391 N95-26947
- Process and control systems for composites manufacturing
p 420 N95-28267
- ACT/ICAPS: Thermoplastic composite activities
p 421 N95-28274
- Composite intermediate case manufacturing scale-up for advanced engines
p 406 N95-28275
- Composite fuselage crown panel manufacturing technology
p 399 N95-28474

MAPPING

- Data processing and mapping in airborne radiometric surveys
[HTN-95-51587] p 442 A95-83591
- Mapping of forest fire damages using imaging spectroscopy
p 442 A95-83627

MARINE ENVIRONMENTS

- Transport phenomena and interfacial kinetics in multiphase combustion systems
[AD-A288297] p 418 N95-26417
- Benefits and limitations of composites in carrier-based aircraft
p 422 N95-28422

MARINE TECHNOLOGY

- JTEC/WTEC annual report and program summary: 1993/94
[NASA-CR-198563] p 454 N95-28038

MASS BALANCE

- The analysis of the processing increased weight for pilot production of F-X aircraft
[HTN-95-71133] p 385 A95-83494

MATERIALS SCIENCE

- JPRS report: Science and technology. Central Eurasia
[JPRS-UST-94-022] p 438 N95-27699

MATERIALS TESTS

- Study on the turbine vane and blade for a 1500 C class industrial gas turbine
[BTN-94-EIX95011441254] p 431 A95-84211

Proof test methodology for composites

- p 424 N95-28445
- Impact damage resistance of composite fuselage structure, part 1
p 399 N95-28482
- NASA-ACEE/Boeing 737 graphite-epoxy horizontal stabilizer service
p 400 N95-28489

MATHEMATICAL LOGIC

- Digital systems validation. Chapter 20 Artificial Intelligence with applications for aircraft. Handbook, volume 2
[AD-A288492] p 448 N95-26638

MATHEMATICAL MODELS

- Nonlinear decoupling control study for aircraft maneuvering flight
[HTN-95-71130] p 408 A95-83491
- Flying qualities development and flight simulation evaluation of the TW-68 tilt-wing VTOL aircraft
[SAE PAPER 932517] p 386 A95-84555
- Assessment of cost and training effectiveness for a candidate training system using the Comparison-Based Prediction model
[SAE PAPER 932598] p 379 A95-84570
- A model for temperature-dependent collisional quenching of OH A(sup 2) Sigma(sup +)
[HTN-95-42308] p 450 A95-85002
- Artificial neural networks for predicting nonlinear dynamic helicopter loads
[HTN-95-51678] p 404 A95-85060
- Matrix fraction approach for finite-state aerodynamic modeling
[BTN-95-EIX95262694311] p 365 A95-85482
- Variational principles for ascent shapes of large scientific balloons
[BTN-95-EIX95262694320] p 387 A95-85491
- Equivalent beam-column analysis of guyed towers
[BTN-95-EIX95262696644] p 435 A95-85519
- Stochastic approach to noise modeling for free turbulent flows
[HTN-95-42321] p 371 A95-86150
- Reduction of blade-vortex interaction noise through porous leading edge
[HTN-95-42324] p 371 A95-86153
- Nonreflective boundary conditions for high-order methods
[HTN-95-42328] p 371 A95-86157
- Simulation model of the integrated flight/propulsion control system, displays, and propulsion system for ASTOVL lift-fan aircraft
[NASA-TM-108866] p 405 N95-26412
- Development of a nonlinear simulation for the McDonnell Douglas F-15 Eagle with a longitudinal TECS control-law
[AD-A288610] p 388 N95-26481
- The 1994 updated National Aerospace System performance assessment for year 2005
[AD-A288652] p 380 N95-26485
- Development and validation of a blade-element mathematical model for the AH-64A Apache helicopter
[NASA-TM-108863] p 367 N95-26710
- Numerical investigation to S-inlet flows (Numerical simulation study of S-inlet flows)
[AD-A289590] p 374 N95-26713
- Numerical simulation of the flow about the F-18 HARV at high angle of attack
[NASA-CR-197755] p 374 N95-26735
- Photoacoustic chambers for studying solids and gases: Theory and practical examples
[IFTR-39/1994] p 412 N95-26837
- A numerical model to predict the fate of jettisoned aviation fuel
[AD-A289336] p 419 N95-26842
- A gain scheduling optimization method using genetic algorithms
[AD-A289306] p 448 N95-26920
- Aircraft nosewheel steering simulation
p 412 N95-26944
- Implementation and demonstration of a multiple model adaptive estimation failure detection system for the F-16
[AD-A289301] p 391 N95-27042
- Probabilistic material strength degradation model for Inconel 718 components subjected to high temperature, high-cycle and low-cycle mechanical fatigue, creep and thermal fatigue effects
[NASA-CR-197832] p 419 N95-27167
- A verification procedure for MSC/NASTRAN Finite Element Models
[NASA-CR-4675] p 392 N95-27371
- Flight Mechanics/Estimation Theory Symposium 1995
[NASA-CP-3299] p 416 N95-27763
- Vibration analysis of a split path gearbox
[NASA-TM-106875] p 438 N95-27855
- Load transfer in the stiffener-to-skin joints of a pressurized fuselage
[NASA-CR-198610] p 439 N95-27865

- Precision landing system mathematical modeling study report for Andrews Air Force Base, runway 19L, Camp Springs, MD
[AD-A289015] p 384 N95-27903
- Collected papers on wind turbine technology
[NASA-CR-195432] p 447 N95-27970
- Preliminary analysis of dynamic stall effects on a 91-meter wind turbine rotor
p 376 N95-27975
- Comparative wind tunnel tests of NACA 23024 airfoils with several aileron and spoiler configurations
p 376 N95-27976
- Comparative performance tests on the Mod-2, 2.5-mW wind turbine with and without vortex generators
p 377 N95-27978
- Design of a real-time wind turbine simulator using a custom parallel architecture
p 449 N95-27979
- Aeroelastic stability of wind turbine blade/aileron systems
p 377 N95-27981
- Whirl plus tilt
[DE95-007948] p 452 N95-28108
- Operator modeling in commercial aviation: Cognitive models, intelligent displays, and pilot's assistants
[NASA-CR-198609] p 401 N95-28203
- Aeroelasticity and structural optimization of composite helicopter rotor blades with swept tips
[NASA-CR-4665] p 397 N95-28262
- Analysis of aircraft engine blade subject to ice impact
p 407 N95-28277
- Structural design optimization with survivability dependent constraints application: Primary wing box of a multi-role fighter
p 398 N95-28440
- Proof test methodology for composites
p 424 N95-28445
- Designers' unified cost model
p 424 N95-28464
- Local design optimization for composite transport fuselage crown panels
p 398 N95-28473
- Nonlinear dynamics and aeroelasticity of rotorcraft in forward flight
[AD-A291714] p 400 N95-28504
- Development of a TECS control-law for the lateral directional axis of the McDonnell Douglas F-15 Eagle
[AD-A289771] p 410 N95-28598
- MATRICES (MATHEMATICS)**
Matrix fraction approach for finite-state aerodynamic modeling
[BTN-95-EIX95262694311] p 365 A95-85482
- Modeling helicopter blade dynamics using a modified Myklestad-Prohl transfer matrix method
[AD-A289891] p 400 N95-28626
- MATRIX METHODS**
Modeling helicopter blade dynamics using a modified Myklestad-Prohl transfer matrix method
[AD-A289891] p 400 N95-28626
- MATRIX THEORY**
Matrix fraction approach for finite-state aerodynamic modeling
[BTN-95-EIX95262694311] p 365 A95-85482
- MCDONNELL AIRCRAFT**
Performance study for inlet installations
[NASA-CR-189714] p 406 N95-28227
- MCDONNELL DOUGLAS AIRCRAFT**
Strategy in the commercial aircraft industry in the United States: A comparison of decisionmaking by McDonnell-Douglas and Boeing aircraft companies from 1977-1983
[AD-A288289] p 366 N95-26409
- MD 11 AIRCRAFT**
Integrated flight crew transition training for the advanced flight deck aircraft
[SAE PAPER 932599] p 380 A95-84571
- MEASURING INSTRUMENTS**
Flutter clearance flight tests of an OV-10A airplane modified for wake vortex flight experiments
[NASA-TM-109168] p 366 N95-26381
- MECHANICAL DRIVES**
Control system design for the MOD-5A 7.3 mW wind turbine generator
p 440 N95-27985
- Variable speed generator application on the MOD-5A 7.3 mW wind turbine generator
p 440 N95-27989
- MECHANICAL ENGINEERING**
Ceramic composite attachments for transmission of high-torque loads
[BTN-94-EIX95011441256] p 417 A95-84213
- MECHANICAL PROPERTIES**
Through-the Thickness(R) braided composites for aircraft applications
p 421 N95-28273
- Application of advanced material systems to composite frame elements
p 422 N95-28432
- MESH**
Automatic riveting cell for commercial aircraft floor grid assembly
[HTN-95-82309] p 365 A95-85353
- METAL FATIGUE**
Status and prospects for aluminium-lithium alloys in aircraft structures
p 387 A95-85893
- Adhesively bonded composite patch repair of cracked aluminum alloy structures
p 393 N95-27507
- METAL SURFACES**
Mechanism of deposit formation on fuel-wetted hot metal surfaces
[AD-A289847] p 426 N95-28621
- METAL-METAL BONDING**
Forming and bonding techniques for high-strength aluminum alloys
[HTN-95-20605] p 418 A95-84786
- METEOROLOGICAL PARAMETERS**
Weather And Radar Processor (WARP) Test and Evaluation Master Plan (TEMP)
[AD-A288280] p 445 N95-26453
- METEOROLOGICAL RADAR**
Weather And Radar Processor (WARP) Test and Evaluation Master Plan (TEMP)
[AD-A288280] p 445 N95-26453
- METEOROLOGICAL RESEARCH AIRCRAFT**
Design of a high altitude long endurance aircraft with manufacturing considerations
p 391 N95-26947
- METHANE**
Stationary premixed flames in spherical and cylindrical geometries
[HTN-95-42336] p 418 A95-86165
- MICROCOMPUTERS**
Control system design for the MOD-5A 7.3 mW wind turbine generator
p 440 N95-27985
- MICROGRAVITY**
Study on a scheme for the prolongation of microgravity time of balloon-borne drop capsule
p 414 A95-82515
- Study of heat transfer rates during quenching of a hot tube under microgravity
p 428 A95-82641
- Experimental investigation of flow-boiling heat transfer under microgravity
p 428 A95-82642
- Stationary premixed flames in spherical and cylindrical geometries
[HTN-95-42336] p 418 A95-86165
- Two-phase flow research using the learjet apparatus
[NASA-TM-106814] p 438 N95-27854
- MICROPROCESSORS**
Micro-time stress measurement device development
[AD-A289511] p 448 N95-26845
- MICROSTRUCTURE**
Applying nanostructured materials to future gas turbine engines
[HTN-95-11909] p 404 A95-85990
- MICROWAVE LANDING SYSTEMS**
An integrated GPS/INS/BARO and radar altimeter system for aircraft precision approach landings
[AD-A289280] p 383 N95-26985
- Precision landing system mathematical modeling study report for Andrews Air Force Base, runway 19L, Camp Springs, MD
[AD-A289015] p 384 N95-27903
- MICROWAVE SCATTERING**
Precision landing system mathematical modeling study report for Andrews Air Force Base, runway 19L, Camp Springs, MD
[AD-A289015] p 384 N95-27903
- MICROWAVES**
Permanent magnet electron cyclotron resonance plasma source with remote window
[BTN-95-EIX95242674338] p 450 A95-82176
- MIE SCATTERING**
Airborne measurements during the Arctic stratospheric experiment: Observation of O3 and NO2
[HTN-95-00748] p 445 A95-86318
- MILITARY AIRCRAFT**
Digital systems validation. Chapter 20 Artificial Intelligence with applications for aircraft. Handbook, volume 2
[AD-A288492] p 448 N95-26638
- Naval Aviation System TEAM mapping, charting, and geodesy handbook
[AD-A288590] p 446 N95-26841
- A review of Australian and New Zealand investigations on aeronautical fatigue during the period Apr. 1993 - Mar. 1995
[AR-009-202] p 397 N95-27918
- Aircraft IR/acoustic detection evaluation. Volume 2: Development of a ground-based acoustic sensor system for the detection of subsonic jet-powered aircraft
[NASA-CR-189705-VOL-2] p 452 N95-28073
- MILITARY HELICOPTERS**
AH-1F COBRA rewire program MANPRINT analysis
[AD-A289190] p 391 N95-27018
- Report to Congressional Committees. Comanche Helicopter: Testing needs to be completed prior to production decisions
[GAO/NSIAD-95-112] p 397 N95-27910
- Construction and wind tunnel test of a 1/12th scale helicopter model
[AD-A288487] p 378 N95-28331
- Tie-down trials involving a Sikorsky S-70B-2 helicopter
[DSTO-TR-0132] p 400 N95-28567
- MILITARY OPERATIONS**
The value of simulation for training
[AD-A289174] p 411 N95-26556
- Digital systems validation. Chapter 20 Artificial Intelligence with applications for aircraft. Handbook, volume 2
[AD-A288492] p 448 N95-26638
- Air cushioned landing craft (LCAC) based ship to shore movement simulation: A decision aid for the amphibious commander. A (SMMAT) application
[AD-A289635] p 436 N95-26722
- MILLIMETER WAVES**
An overview of millimeter-wave spectroscopic measurements of chlorine monoxide at Thule, Greenland, February-March, 1992: Vertical profiles, diurnal variation, and longer-term trends
[HTN-95-00722] p 444 A95-86292
- MINIMA**
Prediction of fatigue crack growth under constant amplitude and random loading using specimens with multiple cracks
[AD-A291614] p 397 N95-28409
- MISSILE CONTROL**
Numerical analysis of flow field around gas rudder
p 407 A95-82333
- The short range attack missile/light weight exo-atmospheric projectile (SRAM/LEAP) missile tests program
[HTN-95-81498] p 386 A95-85212
- Active plate and missile wing development using directionally attached piezoelectric elements
[HTN-95-42340] p 408 A95-86169
- MISSILE DEFENSE**
The short range attack missile/light weight exo-atmospheric projectile (SRAM/LEAP) missile tests program
[HTN-95-81498] p 386 A95-85212
- MISSILE DESIGN**
The short range attack missile/light weight exo-atmospheric projectile (SRAM/LEAP) missile tests program
[HTN-95-81498] p 386 A95-85212
- MISSILE STRUCTURES**
Development of a low-cost, modified resin transfer molding process using elastomeric tooling and automated preform fabrication
p 420 N95-28268
- MISSILE TRAJECTORIES**
Parallel block implicit integration technique for trajectory parallelism
[AD-A288961] p 450 N95-28335
- MISSILES**
Numerical analysis of flow field around gas rudder
p 407 A95-82333
- User documentation of the CTA program
[AD-A289508] p 375 N95-26854
- MIXING LAYERS (FLUIDS)**
Basic studies in turbulent shear flows
[AD-A289145] p 437 N95-26998
- MIXING LENGTH FLOW THEORY**
Supersonic coaxial jet noise predictions
[NASA-TM-106917] p 451 N95-26801
- MOISTURE**
Bonded composite repair of thin metallic materials: Variable load amplitude and temperature cycling effects
p 393 N95-27509
- MOMENTS OF INERTIA**
A quantitative feedback theory FCS design for the subsonic envelope of the VISTA F-16 including configuration variation
[AD-A289221] p 409 N95-26958
- MOMENTUM THEORY**
Rarefied gas effects on aerobraking/reentry vehicles with wakes
[NASA-CR-196586] p 415 N95-27093
- MONOPLANES**
Incorporating biplane wing theory into a large, subsonic, all-cargo transport
p 391 N95-26956
- MONTE CARLO METHOD**
Rarefied gas numerical wind tunnel: OREX and HOPE
p 427 A95-82391
- MOORING**
An in situ evaluation of TOPEX/Poseidon altimetric measurements versus measurements made by moorings and inverted echo sounders for sea surface height
[NASA-CR-198621] p 447 N95-27805
- MOTION SIMULATION**
Air cushioned landing craft (LCAC) based ship to shore movement simulation: A decision aid for the amphibious commander. A (SMMAT) application
[AD-A289635] p 436 N95-26722
- MOTION SIMULATORS**
Collected papers on wind turbine technology
[NASA-CR-195432] p 447 N95-27970
- Design of a real-time wind turbine simulator using a custom parallel architecture
p 449 N95-27979

MOUNTAINS

Airborne lidar observation of mountain-wave-induced polar stratospheric clouds during EASOE
[HTN-95-00738] p 444 A95-86308

MOUNTING

Active plate and missile wing development using directionally attached piezoelectric elements
[HTN-95-42340] p 408 A95-86169

MULTIDISCIPLINARY DESIGN OPTIMIZATION

Structural design optimization with survivability dependent constraints application: Primary wing box of a multi-role fighter p 398 A95-28440

MULTIPATH TRANSMISSION

Precision landing system mathematical modeling study report for Andrews Air Force Base, runway 19L, Camp Springs, MD
[AD-A289015] p 384 A95-27903

N

NACELLES

Application of fiber-reinforced bismaleimide materials to aircraft nacelle structures p 397 A95-28278

NARROWBAND

Analysis and simulation of narrowband GPS jamming using digital excision temporal filtering
[AD-A289328] p 383 A95-26898

NASA PROGRAMS

AIAA Techfest 20 Proceedings
[NIAR-94-1] p 367 A95-26941
The high speed civil transport and NASA's High Speed Research (HSR) program p 390 A95-26945
Research and Technology Objectives and Plans Summary (RTOPS)
[NASA-TM-108574] p 453 A95-28002
Overview of the ACT program p 424 A95-28463
Software process improvement in the NASA software engineering laboratory
[AD-A289912] p 450 A95-28627

NASTRAN

A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines p 439 A95-27980
Applications of a damage tolerance analysis methodology in aircraft design and production p 426 A95-28483

NATIONAL AIRSPACE SYSTEM

The 1994 updated National Airspace System performance assessment for year 2005
[AD-A288652] p 380 A95-26485

NAVIER-STOKES EQUATION

Computational/experimental investigation of staged injection into a Mach 2 flow
[HTN-95-51646] p 432 A95-85028
Practical formulation of a positively conservative scheme
[HTN-95-51668] p 433 A95-85050
Compressible Navier-Stokes computations of multielement airfoil flows using multiblock grids
[HTN-95-42327] p 371 A95-86156
Using the Liou-Steffen algorithm for the Euler and Navier-Stokes equations
[HTN-95-42348] p 373 A95-86177
Computational analysis of forebody tangential slot blowing on the high alpha research vehicle
[NASA-CR-197754] p 389 A95-26591
Study of potential aerodynamic benefits from spanwise blowing at wingtip
[NASA-TP-3515] p 378 A95-28669
Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils
[NASA-TP-3496] p 378 A95-28674

NAVIGATION

Operator modeling in commercial aviation: Cognitive models, intelligent displays, and pilot's assistants
[NASA-CR-198609] p 401 A95-28203

NAVIGATION INSTRUMENTS

Flight evaluation of GPS/DGPS sensor systems installed in NAL Do228
[NAL-TR-1230] p 382 A95-26585

NAVIGATION SATELLITES

Analysis and simulation of narrowband GPS jamming using digital excision temporal filtering
[AD-A289328] p 383 A95-26898
Determining GPS average performance metrics p 383 A95-27791

NAVIGATORS

An analysis of the KC-135 three-person cockpit
[AD-A289540] p 390 A95-26873

NAVY

Naval Aviation System TEAM mapping, charting, and geodesy handbook
[AD-A288590] p 446 A95-26841
Navy composite maintenance and repair experience p 424 A95-28446

NEAR FIELDS

Near field of a coaxial jet with and without axial excitation
[HTN-95-42332] p 372 A95-86161

Development of a large-aspect-ratio rectangular turbulent free jet
[HTN-95-42333] p 372 A95-86162

Active open-loop control of particle dispersion in round jets
[HTN-95-42334] p 372 A95-86163

NEAR WAKES

Effects of three-dimensional imposed 3-D disturbances on bluff-body near wake flows
[AD-A289553] p 374 A95-26757
The near-wake flow behavior of an oscillating airfoil with modified trailing edge p 375 A95-26953

NEURAL NETS

Neuro-controllers for adaptive helicopter training
[SAE PAPER 932535] p 379 A95-84557
Artificial neural networks for predicting nonlinear dynamic helicopter loads
[HTN-95-51678] p 404 A95-85060
Artificial intelligence for turboprop engine maintenance
[HTN-95-92313] p 404 A95-85357
Digital systems validation. Chapter 20 Artificial Intelligence with applications for aircraft. Handbook, volume 2
[AD-A288492] p 448 A95-26638
An exploratory application of neural networks for airfoil design p 448 A95-26943

NEUTRAL BUOYANCY SIMULATION

Education, training, and human engineering in aerospace: SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993
[SAE SP-992] p 417 A95-84553

NEW ZEALAND

A review of Australian and New Zealand investigations on aeronautical fatigue during the period Apr. 1993 - Mar. 1995
[AR-009-202] p 397 A95-27918

NICKEL ALLOYS

Study on the turbine vane and blade for a 1500 C class industrial gas turbine
[BTN-94-EIX95011441254] p 431 A95-84211

NITRIC ACID

Airborne measurements during the European Arctic Stratospheric Ozone Experiment column amounts of HNO₃ and O₃ derived from FTIR emission sounding
[HTN-95-00742] p 445 A95-86312

NITRIC OXIDE

Nitrogen oxide emissions characteristics of augmented turbofan engines
[BTN-94-EIX95011441240] p 403 A95-84197

NITROGEN DIOXIDE

Nitrogen oxide emissions characteristics of augmented turbofan engines
[BTN-94-EIX95011441240] p 403 A95-84197
Airborne measurements during the Arctic stratospheric experiment: Observation of O₃ and NO₂
[HTN-95-00748] p 445 A95-86318

NITROGEN OXIDES

Aircraft gas turbine emissions challenge
[BTN-94-EIX95011441239] p 403 A95-84196
Evolution of the concentrations of trace species in an aircraft plume: Trajectory study
[HTN-95-A1044] p 443 A95-84549

NOISE (SOUND)

A higher harmonic control test in the DNW to reduce impulsive BVI noise
[HTN-95-61071] p 385 A95-83655

NOISE MEASUREMENT

A higher harmonic control test in the DNW to reduce impulsive BVI noise
[HTN-95-61071] p 385 A95-83655

NOISE PREDICTION

Stochastic approach to noise modeling for free turbulent flows
[HTN-95-42321] p 371 A95-86150
A numerical study of fundamental shock noise mechanisms
[NASA-TM-110608] p 451 A95-27908
Measurement and prediction of broadband noise from large horizontal axis wind turbine generators p 451 A95-27990

Flow structure generated by perpendicular blade vortex interaction and implications for helicopter noise predictions
[NASA-CR-198590] p 377 A95-28193

Response of multi-panel assembly to noise from a jet in forward motion
[NASA-CR-198164] p 442 A95-28673

NOISE PREDICTION (AIRCRAFT)

Structure of supersonic jet flow and its radiated sound
[HTN-95-51645] p 431 A95-85027

Aircraft noise prediction program theoretical manual: Rotorcraft System Noise Prediction System (ROTONET), part 4
[NASA-TM-83199-PT-4] p 451 A95-26392
Supersonic coaxial jet noise predictions
[NASA-TM-106917] p 451 A95-26801

NOISE PROPAGATION

Screech tones from free and ducted supersonic jets
[HTN-95-51647] p 432 A95-85029

NOISE REDUCTION

A higher harmonic control test in the DNW to reduce impulsive BVI noise
[HTN-95-61071] p 385 A95-83655
Screech tones from free and ducted supersonic jets
[HTN-95-51647] p 432 A95-85029
Mixing enhancement by and noise characteristics of streamwise vortices in an air jet
[HTN-95-42322] p 371 A95-86151
Reduction of blade-vortex interaction noise through porous leading edge
[HTN-95-42324] p 371 A95-86153
Supersonic coaxial jet noise predictions
[NASA-TM-106917] p 451 A95-26801
The noise reduction potential of dual-stream coaxial rectangular improperly expanded jet flows
[NASA-CR-197820] p 437 A95-26995
Evaluation of a doubly-swept blade tip for rotorcraft noise reduction
[NASA-CR-189677] p 452 A95-28264
Noise exposure reduction of advanced high-lift systems
[NASA-CR-195077] p 452 A95-28670

NOISE SPECTRA

Measurement and prediction of broadband noise from large horizontal axis wind turbine generators p 451 A95-27990
Observed acoustic and aeroelastic spectral responses of a MOD-2 turbine blade to turbulence excitation p 451 A95-27991

NONDESTRUCTIVE TESTS

Characterization of corrosion and development of a breadboard of a D sight aircraft inspection system, phase 1
[AD-A288347] p 380 A95-26527

NONEQUILIBRIUM FLOW

Viscous shock-layer analysis on hypersonic flow over reentry capsule with nonequilibrium chemistry
[ISAS-656] p 436 A95-26739

NONINTRUSIVE MEASUREMENT

Surface interference in Rayleigh scattering measurements near forebodies
[HTN-95-51670] p 433 A95-85052

NONLINEAR EQUATIONS

Subharmonic and quasi-periodic motions of an eccentric squeeze film damper-mounted rigid rotor
[BTN-94-EIX95011440601] p 429 A95-82982
Development of a nonlinear simulation for the McDonnell Douglas F-15 Eagle with a longitudinal TECS control-law
[AD-A288610] p 388 A95-26481
An easy way to analyze longitudinal and lateral-directional trim problems with AEO or OEI p 409 A95-26949

NONLINEAR SYSTEMS

Nonlinear observer and its application in flight control p 447 A95-82449
Nonlinear decoupling control study for aircraft maneuvering flight
[HTN-95-71130] p 408 A95-83491
GETRAN: A generic, modularly structured computer code for simulation of dynamic behavior of aero- and power generation gas turbine engines
[BTN-94-EIX95011441241] p 431 A95-84198
Artificial neural networks for predicting nonlinear dynamic helicopter loads
[HTN-95-51678] p 404 A95-85060
Scheduling of local nonlinear control laws by exogenous signals - an application to flight control
[BTN-95-EIX95262694059] p 447 A95-85675
A gain scheduling optimization method using genetic algorithms
[AD-A289306] p 448 A95-26920
Nonlinear dynamics and aeroelasticity of rotorcraft in forward flight
[AD-A291714] p 400 A95-28504

NONLINEARITY

Non-linear analysis provides new insights into impact damage of composite structures
[HTN-95-42368] p 418 A95-86197
Bearing defect signature analysis using advanced nonlinear signal analysis in a controlled environment
[NASA-TM-108491] p 441 A95-28364

NOTCH SENSITIVITY

Tension fracture of laminates for transport fuselage. Part 1: Material screening p 398 A95-28471

NOZZLE DESIGN

- Studies on gain performance of a combustion driven CO₂ gas dynamic laser p 428 A95-82679
- NASA-Lewis tests Allison ASTOVL nozzle [HTN-95-20603] p 404 A95-84784
- The noise reduction potential of dual-stream coaxial rectangular improperly expanded jet flows [NASA-CR-197820] p 437 N95-26995

NOZZLE FLOW

- Evaluation of scramjet nozzle performance p 402 A95-82321
- An experimental investigation of scramjet nozzle flow p 402 A95-82322
- An investigation of the AFIT 2-inch shock tube as a flow source for supersonic testing [AD-A289246] p 412 N95-26966
- A laboratory scale supersonic combustive flow system [DE95-006347] p 420 N95-27851

NUMERICAL ANALYSIS

- Numerical analysis of flow field around gas rudder p 407 A95-82333
- Compressible Navier-Stokes computations of multielement airfoil flows using multiblock grids [HTN-95-42327] p 371 A95-86156
- A numerical study of fundamental shock noise mechanisms [NASA-TM-110608] p 451 N95-27908
- Numerical analysis of intra-cavity and power-stream flow interaction in multiple gas-turbine disk-cavities [NASA-TM-106886] p 407 N95-28344

NUMERICAL CONTROL

- Process and control systems for composites manufacturing p 420 N95-28267

NUMERICAL FLOW VISUALIZATION

- Numerical investigation of cylinder wake flow with a rear stagnation jet [HTN-95-51669] p 433 A95-85051

NYLON (TRADEMARK)

- Recent developments in nylon superpressure balloons p 385 A95-82512

O

OBJECT-ORIENTED PROGRAMMING

- Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993 [SAE SP-992] p 417 A95-84553
- New tools for creating instruction and simulations [SAE PAPER 932600] p 380 A95-84572
- EASY-SIM: A visual simulation system software architecture with an Ada 9X application framework [AD-A289325] p 448 N95-26895

OBLIQUE WINGS

- Preliminary design problems and solutions for a supersonic oblique all-wing transport aircraft p 390 N95-26942

OBSERVABILITY (SYSTEMS)

- Nonlinear observer and its application in flight control p 447 A95-82449

OCEAN SURFACE

- An in situ evaluation of TOPEX/Poseidon altimetric measurements versus measurements made by moorings and inverted echo sounders for sea surface height [NASA-CR-198621] p 447 N95-27805

OCEANOGRAPHY

- Airborne geophysics and precise positioning: Scientific issues and future directions [LC-94-68678] p 446 N95-27156

OH-58 HELICOPTER

- Condition monitoring and diagnostics [HTN-95-92312] p 387 A95-85356

OPERATIONAL PROBLEMS

- Air traffic operational inventory CY 1994 [AD-A288281] p 382 N95-26454

OPTICAL THICKNESS

- Air truth validation of cloud albedo estimated from NOAA advanced very high resolution radiometer data [HTN-95-A1021] p 443 A95-84526

OPTIMAL CONTROL

- Flight control design using mixed H₂/micron optimization [AD-A289288] p 410 N95-27036

OPTIMIZATION

- Optimal trajectories for hypersonic launch vehicles [HTN-95-61120] p 415 A95-84884
- Supersonic transport grid generation, validation, and optimization [NASA-CR-197752] p 448 N95-26648
- Creating an alternative parameter optimization method (APO) p 375 N95-26946
- Optimization of wave rotors for use as gas turbine engine topping cycles [NASA-TM-106951] p 406 N95-27860

- Local design optimization for composite transport fuselage crown panels p 398 N95-28473

ORBIT CALCULATION

- Flight Mechanics/Estimation Theory Symposium 1995 [NASA-CP-3299] p 416 N95-27763

ORBITAL MANEUVERS

- The effect of high lift to drag ratio on aerobraking p 415 A95-85807

ORBITAL VELOCITY

- The effect of high lift to drag ratio on aerobraking p 415 A95-85807

OSCILLATION DAMPERS

- An analytical model for a nonlinear elastomeric lag damper and its effect on aeromechanical stability in Hover [HTN-95-61076] p 369 A95-83660

OSCILLATIONS

- Suppressor of oscillations in airframe cavities [AD-D017265] p 388 N95-26507
- Visualization of the multiple supersonic jet oscillations by swept focused strobed schlieren technique p 367 N95-26952
- The near-wake flow behavior of an oscillating airfoil with modified trailing edge p 375 N95-26953

OV-10 AIRCRAFT

- Flutter clearance flight tests of an OV-10A airplane modified for wake vortex flight experiments [NASA-TM-109168] p 366 N95-26381

OXIDATION

- Mechanism of deposit formation on fuel-wetted hot metal surfaces [AD-A289847] p 426 N95-28621

OXIDE FILMS

- Transport phenomena and interfacial kinetics in multiphase combustion systems [AD-A288297] p 418 N95-26417

OXYGEN

- General solution procedure for flows in local chemical equilibrium [HTN-95-42329] p 404 A95-86158

OZONE

- Evolution of the concentrations of trace species in an aircraft plume: Trajectory study [HTN-95-A1044] p 443 A95-84549
- Airborne measurements during the European Arctic Stratospheric Ozone Experiment column amounts of HNO₃ and O₃ derived from FTIR emission sounding [HTN-95-00742] p 445 A95-86312
- Airborne measurements during the Arctic stratospheric experiment: Observation of O₃ and NO₂ [HTN-95-00748] p 445 A95-86318

OZONE DEPLETION

- Effects of a polar stratospheric cloud parameterization on ozone depletion due to stratospheric aircraft in a two-dimensional model [HTN-95-A1038] p 443 A95-84543
- An overview of the EASOE campaign [HTN-95-00702] p 443 A95-86272

OZONOMETRY

- An overview of the EASOE campaign [HTN-95-00702] p 443 A95-86272

P

PAINTS

- Aircraft stripping and painting [HTN-95-92311] p 365 A95-85355

PANEL METHOD (FLUID DYNAMICS)

- Precision requirement for potential-based panel methods [HTN-95-51666] p 433 A95-85048
- Explicit Kutta condition for an unsteady two-dimensional constant potential panel method [HTN-95-51679] p 433 A95-85061
- TransAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document [NASA-CR-4348] p 378 N95-28265

PANELS

- Experiment and analysis on heat transfer of a scramjet leading edge model p 403 A95-82420
- Interaction of jet noise with a nearby panel assembly [BTN-95-EIX95262694295] p 434 A95-85466
- Composite fuselage crown panel manufacturing technology p 399 N95-28474
- Effect of low-speed impact damage and damage location on behavior of composite panels p 426 N95-28481
- Response of multi-panel assembly to noise from a jet in forward motion [NASA-CR-198164] p 442 N95-28673

PARACHUTES

- Wind tunnel experiments on wake flow field behind a reentry capsule from a viewpoint of parachute deployment at supersonic speeds [ISAS-655] p 374 N95-26740
- The performance of cargo airdrop systems using g-12E parachutes: Statistical determination of minimum altitude [AD-A291666] p 381 N95-28454

PARALLEL COMPUTERS

- Aeroelasticity of wing and wing-body configurations on parallel computers [NASA-CR-197756] p 389 N95-26590

PARALLEL PROCESSING (COMPUTERS)

- A fixed time performance evaluation of parallel CFD applications [DE94-014240] p 436 N95-26445
- Aeroelasticity of wing and wing-body configurations on parallel computers [NASA-CR-197756] p 389 N95-26590
- An exploratory application of neural networks for airfoil design p 448 N95-26943
- NAS Technical Summaries, March 1993 - February 1994 [NASA-RP-1355] p 453 N95-27367
- Design of a real-time wind turbine simulator using a custom parallel architecture p 449 N95-27979
- Parallel block implicit integration technique for trajectory parallelism [AD-A288961] p 450 N95-28335

PARALLEL PROGRAMMING

- Parallel block implicit integration technique for trajectory parallelism [AD-A288961] p 450 N95-28335

PARAMETERIZATION

- Effects of a polar stratospheric cloud parameterization on ozone depletion due to stratospheric aircraft in a two-dimensional model [HTN-95-A1038] p 443 A95-84543

PARTIAL DIFFERENTIAL EQUATIONS

- Instability of three-dimensional boundary layers due to streamline curvature [HTN-95-61070] p 430 A95-83654

PASSENGERS

- Enplanement and all cargo activity [AD-A280074] p 412 N95-28151

PAYLOAD MASS RATIO

- Optimal trajectories for hypersonic launch vehicles [HTN-95-61120] p 415 A95-84884

PEACETIME

- Surviving the peace. Lessons learned from the aircraft industry in the 1920s and 1930s [AD-A288284] p 366 N95-26455

PERFORMANCE PREDICTION

- Prediction of pre-combustion shock in scramjet combustors: A new method p 402 A95-82323
- Condition monitoring and diagnostics [HTN-95-92312] p 387 A95-85356
- Air cushioned landing craft (LCAC) based ship to shore movement simulation: A decision aid for the amphibious commander. A (SMMAT) application [AD-A289635] p 436 N95-26722
- A study of workstation computational performance for real-time flight simulation [NASA-TM-109184] p 449 N95-27241
- Determining GPS average performance metrics p 383 N95-27791
- Horizontal axis wind turbine post stall airfoil characteristics synthesisization p 376 N95-27974
- Calculation of design load for the MOD-SA 7.3 mW wind turbine system p 440 N95-27982

PERFORMANCE TESTS

- Flex cycle combustor development and demonstration [BTN-94-EIX95011441245] p 417 A95-84202
- Pressure and temperature distortion testing of a two-stage centrifugal compressor [BTN-94-EIX95011441250] p 431 A95-84207
- NASA-Lewis tests Allison ASTOVL nozzle [HTN-95-20603] p 404 A95-84784
- T-45A high angle attack testing [HTN-95-81499] p 386 A95-85213
- Weather And Radar Processor (WARP) Test and Evaluation Master Plan (TEMP) [AD-A288280] p 445 N95-26453
- Aircraft fuel system lightning protection design and qualification test procedures development [AD-A288401] p 380 N95-26497
- Development of repair processes and sources for C/KC-135 aircraft windows/windshields [AD-A288348] p 367 N95-26629
- Design and testing of low sonic boom configurations and an oblique all-wing supersonic transport [NASA-CR-197744] p 389 N95-26651
- The effects of UH-1 experience on UH-60 simulator performance: A preliminary study [AD-A289457] p 391 N95-26993

- The noise reduction potential of dual-stream coaxial rectangular improperly expanded jet flows
[NASA-CR-197820] p 437 N95-26995
- Sailplane glide performance and control using fixed and articulating winglets
[NASA-CR-198579] p 392 N95-27180
- Propulsion system assessment for very high UAV under ERAST
[NASA-CR-195469] p 406 N95-27866
- Collected papers on wind turbine technology
[NASA-CR-195432] p 447 N95-27970
- Comparative performance tests on the Mod-2, 2.5-mW wind turbine with and without vortex generators
p 377 N95-27978
- Experimental investigation of inlet-combustor isolators for a dual-mode scramjet at a Mach number of 4
[NASA-TP-3502] p 407 N95-28343
- PERIODIC VARIATIONS**
Determining GPS average performance metrics
p 383 N95-27791
- PERMANENT MAGNETS**
Permanent magnet electron cyclotron resonance plasma source with remote window
[BTN-95-EIX95242674338] p 450 A95-82176
- PERSPEX (TRADEMARK)**
Non-linear viscoelastic-plastic constitutive relations for an aeronautical PMMA
[HTN-95-71132] p 385 A95-83493
- PERTURBATION**
The effects of wall perturbations on thermo-turbulent Couette flow
[HTN-95-92255] p 434 A95-85299
- Suppressor of oscillations in airframe cavities
[AD-DO17265] p 388 N95-26507
- PHILIPPINES**
Two dimensional stratospheric aerosol distributions during EASOE
[HTN-95-00726] p 444 A95-86296
- Airborne measurements during the Arctic stratospheric experiment: Observation of O3 and NO2
[HTN-95-00748] p 445 A95-86318
- PHOTOACOUSTIC SPECTROSCOPY**
Photoacoustic chambers for studying solids and gases: Theory and practical examples
[IFTR-39/1994] p 412 N95-26837
- PHOTOCHEMICAL REACTIONS**
Evolution of the concentrations of trace species in an aircraft plume: Trajectory study
[HTN-95-A1044] p 443 A95-84549
- PHYSICAL OPTICS**
Time-domain imaging of airborne targets using ultra-wideband or short-pulse radar
[BTN-95-EIX95242673673] p 450 A95-82251
- PIEZOELECTRIC CERAMICS**
Active plate and missile wing development using directionally attached piezoelectric elements
[HTN-95-42340] p 408 A95-86169
- PIEZOELECTRICITY**
Vibrational behavior of adaptive aircraft wing structures modelled as composite thin-walled beams
p 423 N95-28435
- PILOT PERFORMANCE**
Automated hover training: An empirical evaluation
[SAE PAPER 932536] p 379 A95-84559
- Pilot rating scale for aircraft handling qualities
[HTN-95-42269] p 380 A95-84963
- The effects of UH-1 experience on UH-60 simulator performance: A preliminary study
[AD-A289457] p 391 N95-26993
- PILOT TRAINING**
Education, training, and human engineering in aerospace: SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993
[SAE SP-992] p 417 A95-84553
- Neuro-controllers for adaptive helicopter training
[SAE PAPER 932535] p 379 A95-84557
- Intelligent flight trainer for initial rotary wing training
[SAE PAPER 932536] p 386 A95-84558
- The large radius track centrifuge concept as an acceleration research and simulation device
p 379 A95-84560
- The CBT alternative for aviation training: Is it meeting the need?
[SAE PAPER 932596] p 379 A95-84568
- PILOTLESS AIRCRAFT**
Design and synthesis of a real-time controller for an unmanned air vehicle
[AD-A289134] p 408 N95-26555
- Propulsion system assessment for very high UAV under ERAST
[NASA-CR-195469] p 406 N95-27866
- Unmanned aerial vehicles, 1994 master plan
[AD-A291628] p 398 N95-28411

PILOTS (PERSONNEL)

- Development of a coding form for approach control/pilot voice communications
[DOT/FAA/AM-95/15] p 384 N95-28540

PIPES (TUBES)

- Study of heat transfer rates during quenching of a hot tube under microgravity
p 428 A95-82641
- Experimental investigation of flow-boiling heat transfer under microgravity
p 428 A95-82642

PITCH (INCLINATION)

- On the influence of time-varying flow velocity on unsteady aerodynamics
[HTN-95-61073] p 369 A95-83657
- Interferometric investigations of compressible dynamic stall over a transiently pitching airfoil
[HTN-95-42338] p 372 A95-86167
- An investigation of the effects of pitch-roll (de)coupling on helicopter handling qualities
[NASA-TM-110349] p 409 N95-26773

PITCHING MOMENTS

- Force and moment on a Joukowski profile in the presence of point vortices
[BTN-95-EIX95262694298] p 434 A95-85469
- A comparison of the Neal-Smith and omega Tau function, zeta function and tau function flying qualities criteria
[AD-A289503] p 390 N95-26844

PIVOTS

- Status of bonded boron/epoxy doublers for military and commercial aircraft structures
p 393 N95-27506

PLANETARY MAPPING

- Naval Aviation System TEAM mapping, charting, and geodesy handbook
[AD-A288590] p 446 N95-26841

PLASMA JETS

- Studies on plasma jet igniters
p 403 A95-82680

PLASMAS (PHYSICS)

- Permanent magnet electron cyclotron resonance plasma source with remote window
[BTN-95-EIX95242674338] p 450 A95-82176

PLASTIC DEFORMATION

- Non-linear viscoelastic-plastic constitutive relations for an aeronautical PMMA
[HTN-95-71132] p 385 A95-83493

PLATES (STRUCTURAL MEMBERS)

- Stability of viscoelastic plate in supersonic flow under random loading
[BTN-95-EIX95262694312] p 435 A95-85483
- Convection heat transfer distributions over plates with square ribs from infrared thermography measurements
[HTN-95-20713] p 435 A95-86603
- Compressive strength of damaged and repaired composite plates
p 442 N95-28484
- Fundamental concepts in the suppression of delamination buckling by stitching
p 426 N95-28486

PLUMES

- Evolution of the concentrations of trace species in an aircraft plume: Trajectory study
[HTN-95-A1044] p 443 A95-84549

PNEUMATIC EQUIPMENT

- Design and development of a test rig for the high frequency testing of rolling sleeve airsprings
[DSTO-TN-0001] p 411 N95-26378

POLAR COORDINATES

- User documentation of the CTA program
[AD-A289508] p 375 N95-26854

POLAR METEOROLOGY

- An overview of the EASOE campaign
[HTN-95-00702] p 443 A95-86272
- Replicator for characterization of cirrus and polar stratospheric cloud particles
[NASA-CR-197785] p 445 N95-26669

POLAR REGIONS

- Polar Patrol Balloon system and preliminary experimental results
p 368 A95-82513

POLLUTION

- Community relations plan: Galena Airport and Camp ion Air Force Station, Alaska
[AD-A286722] p 446 N95-27234

POLYETHYLENES

- Development and flight results of fiber reinforced balloon
p 384 A95-82511

POLYMER MATRIX COMPOSITES

- Advanced wing design survivability testing and results
p 400 N95-28488

POLYMETHYL METHACRYLATE

- Non-linear viscoelastic-plastic constitutive relations for an aeronautical PMMA
[HTN-95-71132] p 385 A95-83493

POLYNOMIALS

- Matrix fraction approach for finite-state aerodynamic modeling
[BTN-95-EIX95262694311] p 365 A95-85482

POROUS BOUNDARY LAYER CONTROL

- Computational analysis of buffet alleviation in viscous transonic flow over a porous airfoil
[BTN-95-EIX95262694321] p 366 A95-85492
- Reduction of blade-vortex interaction noise through porous leading edge
[HTN-95-42324] p 371 A95-86153

POSITION (LOCATION)

- Electro-hydraulic actuator controller design using quantitative feedback theory
[AD-A289220] p 409 N95-26957
- Effects of floor location on response of composite fuselage frames
p 423 N95-28439

POSITION ERRORS

- Flight evaluation of GPS/DGPS sensor systems installed in NAL Do228
[NAL-TR-1230] p 382 N95-26585

POSITIONING

- Airborne geophysics and precise positioning: Scientific issues and future directions
[LC-94-68678] p 446 N95-27156

POTENTIAL ENERGY

- Precision requirement for potential-based panel methods
[HTN-95-51666] p 433 A95-85048
- Explicit Kutta condition for an unsteady two-dimensional constant potential panel method
[HTN-95-51679] p 433 A95-85061

POTENTIAL FLOW

- Computational fluid dynamics and transonic flow
[AD-A288962] p 436 N95-26405

POWER FACTOR CONTROLLERS

- Control system design for the MOD-5A 7.3 mW wind turbine generator
p 440 N95-27985

PRECISION

- Precision requirement for potential-based panel methods
[HTN-95-51666] p 433 A95-85048
- An integrated GPS/INS/BARO and radar altimeter system for aircraft precision approach landings
[AD-A289280] p 383 N95-26985

PREDICTION ANALYSIS TECHNIQUES

- Prediction of pre-combustion shock in scramjet combustors: A new method
p 402 A95-82323
- Artificial neural networks for predicting nonlinear dynamic helicopter loads
[HTN-95-51678] p 404 A95-85060
- Aircraft noise prediction program theoretical manual: Rotorcraft System Noise Prediction System (ROTONET), part 4
[NASA-TM-83199-PT-4] p 451 N95-26392
- A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines
p 439 N95-27980
- Calculation of design load for the MOD-5A 7.3 mW wind turbine system
p 440 N95-27982
- Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system
p 440 N95-27983
- Applications of a damage tolerance analysis methodology in aircraft design and production
p 426 N95-28483

PREFORMS

- Through-the Thickness(R) braided composites for aircraft applications
p 421 N95-28273
- Resin transfer molding of textile preforms for aircraft structural applications
p 421 N95-28276
- Recent progress in NASA Langley textile reinforced composites program
p 425 N95-28475
- Advanced textile applications for primary aircraft structures
p 399 N95-28476
- Comparison of resin film infusion, resin transfer molding, and consolidation of textile preforms for primary aircraft structure
p 425 N95-28477

PREMIXED FLAMES

- Stationary premixed flames in spherical and cylindrical geometries
[HTN-95-42336] p 418 A95-86165

PREMIXING

- Ignition analysis of hydrogen/air mixture in supersonic mixing layer
p 416 A95-82301

PREPREGS

- Scarf joint technique with cocured and precured patches for composite repair
p 396 N95-27524
- Advanced tow placement of composite fuselage structure
p 420 N95-28271

PRESSURE

- Differencing of density in compressible flow for a pressure-based approach
[HTN-95-42349] p 373 A95-86178

PRESSURE DISTRIBUTION

- The aerodynamic characteristics of cup-like body in supersonic flow
p 427 A95-82407
- Practical formulation of a positively conservative scheme
[HTN-95-51668] p 433 A95-85050

Airfoil modification effects on subsonic and transonic pressure distributions and performance for the EA-6B airplane
[NASA-TP-3516] p 373 N95-26382

Wind tunnel experiments on wake flow field behind a reentry capsule from a viewpoint of parachute deployment at supersonic speeds
[ISAS-655] p 374 N95-26740

Comparative wind tunnel test at high Reynolds numbers of NACA 64 621 airfoils with two aileron configurations
p 377 N95-27977

Measurements of store forces and moments and cavity pressures for a generic store in and near a box cavity at subsonic and transonic speeds
[NASA-TM-4611] p 378 N95-28241

PRESSURE EFFECTS
Pressure and temperature distortion testing of a two-stage centrifugal compressor
[BTN-94-EIX95011441250] p 431 A95-84207

Load transfer in the stiffener-to-skin joints of a pressurized fuselage
[NASA-CR-198610] p 439 N95-27865

Composite fuselage shell structures research at NASA Langley Research Center
p 425 N95-28466

PRESSURE MEASUREMENT
Stall precursor study of high frequency data for three high speed, swept compressor rotors
[AD-A289379] p 406 N95-26878

PRESSURE RATIO
The noise reduction potential of dual-stream coaxial rectangular improperly expanded jet flows
[NASA-CR-197820] p 437 N95-26995

PRESSURE SENSORS
Process and control systems for composites manufacturing
p 420 N95-28267

PRESSURE VESSELS
Process and control systems for composites manufacturing
p 420 N95-28267

PRINTED CIRCUITS
Life cycle costs of alternatives for F-16 printed circuit board diagnosis equipment
[AD-A288744] p 401 N95-28586

PROBABILITY DISTRIBUTION FUNCTIONS
Probabilistic evaluation of fuselage-type composite structures
p 398 N95-28444

PROBABILITY THEORY
Probabilistic design of advanced composite structure
p 424 N95-28443

Proof test methodology for composites
p 424 N95-28445

PROCEDURES
Maintenance programs
[HTN-95-92310] p 365 A95-85354

PROCESS CONTROL (INDUSTRY)
STEP: A future vision, today
[NONP-NASA-VT-95-49121] p 452 N95-27209

PROGRAM VERIFICATION (COMPUTERS)
An evaluation of the Software Through Pictures/T Tool (SiP/T) for the Software Support Activity (SSA)
[AD-A288822] p 447 N95-26348

A verification procedure for MSC/NASTRAN Finite Element Models
[NASA-CR-4675] p 392 N95-27371

Calculation of design load for the MOD-5A 7.3 mW wind turbine system
p 440 N95-27982

PROPELLER BLADES
Development and validation of a blade-element mathematical model for the AH-64A Apache helicopter
[NASA-TM-108863] p 367 N95-26710

Analysis of aircraft engine blade subject to ice impact
p 407 N95-28277

PROPULSION
The lift-fan aircraft: Lessons learned
[NASA-CR-196694] p 392 N95-27143

NAS Technical Summaries, March 1993 - February 1994
[NASA-RP-1355] p 453 N95-27367

PROPULSION SYSTEM CONFIGURATIONS
An advanced scramjet propulsion concept for A 350 MG SSTO space plane
p 402 A95-82325

Test results on air turbo ramjet engine for a future space plane
p 402 A95-82327

Simulation model of the integrated flight/propulsion control system, displays, and propulsion system for ASTOVL lift-fan aircraft
[NASA-TM-108866] p 405 N95-26412

Propulsion system assessment for very high UAV under ERAST
[NASA-CR-195469] p 406 N95-27866

PROPULSION SYSTEM PERFORMANCE
Optimal trajectories for hypersonic launch vehicles
[HTN-95-61120] p 415 A95-84884

PROPULSIVE EFFICIENCY
Propulsion system assessment for very high UAV under ERAST
[NASA-CR-195469] p 406 N95-27866

PROTECTION
Aircraft fuel system lightning protection design and qualification test procedures development
[AD-A288401] p 380 N95-26497

PROVING
Supersonic transport gnd generation, validation, and optimization
[NASA-CR-197752] p 448 N95-26648

Proof test methodology for composites
p 424 N95-28445

PUBLIC RELATIONS
Community relations plan: Galena Airport and Camp ion Air Force Station, Alaska
[AD-A286722] p 446 N95-27234

PULSE RADAR
Time-domain imaging of airborne targets using ultra-wideband or short-pulse radar
[BTN-95-EIX95242673673] p 450 A95-82251

PURGING
Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics
[NASA-TM-106685] p 416 N95-27434

Q

QUALITY CONTROL
STEP: A future vision, today
[NONP-NASA-VT-95-49121] p 452 N95-27209

The development of an engineering standard for composite repairs
p 396 N95-27528

QUENCHING (ATOMIC PHYSICS)
A model for temperature-dependent collisional quenching of OH A(sup 2) Sigma(sup +)
[HTN-95-42308] p 450 A95-85002

QUENCHING (COOLING)
Study of heat transfer rates during quenching of a hot tube under microgravity
p 428 A95-82641

Experimental investigation of flow-boiling heat transfer under microgravity
p 428 A95-82642

R

RABBITS
Advanced formation flight control
[AD-A289271] p 409 N95-26981

RADAR CROSS SECTIONS
Analysis of backscattering from wing and fuselage joints
[HTN-95-71134] p 430 A95-83495

RADAR DATA
Classification of ultra high range resolution radar using decision boundary analysis
[AD-A289378] p 437 N95-26877

RADAR IMAGERY
Time-domain imaging of airborne targets using ultra-wideband or short-pulse radar
[BTN-95-EIX95242673673] p 450 A95-82251

RADAR SCATTERING
Hybrid finite element-modal analysis of jet engine inlet scattering
[BTN-95-EIX95242673665] p 427 A95-82259

RADAR TARGETS
Time-domain imaging of airborne targets using ultra-wideband or short-pulse radar
[BTN-95-EIX95242673673] p 450 A95-82251

RADAR TRACKING
Classification of ultra high range resolution radar using decision boundary analysis
[AD-A289378] p 437 N95-26877

RADIAL FLOW
A general theory of two- and three-dimensional rotational flow in subsonic and transonic turbomachines
[NASA-CR-4496] p 377 N95-28003

RADIATION EFFECTS
Contribution of thermal radiation to the temperature profile of ceramic composite materials
[BTN-94-EIX95011441252] p 417 A95-84209

RADIATION PROTECTION
Radiation safety aspects of commercial high-speed flight transportation
[NASA-TP-3524] p 453 N95-26427

RADIATIVE HEAT TRANSFER
An experimental study on radiation from strong shock layer
p 368 A95-82421

CAE for thermal management of aerospace electronic boards using the BETAsoft program
p 438 N95-27354

RADIATIVE TRANSFER
Contribution of thermal radiation to the temperature profile of ceramic composite materials
[BTN-94-EIX95011441252] p 417 A95-84209

Air truth validation of cloud albedo estimated from NOAA advanced very high resolution radiometer data
[HTN-95-A1021] p 443 A95-84526

RADIO ALTIMETERS
An integrated GPS/INS/BARO and radar altimeter system for aircraft precision approach landings
[AD-A289280] p 383 N95-26985

RADIO NAVIGATION
Analysis and simulation of narrowband GPS jamming using digital excision temporal filtering
[AD-A289328] p 383 N95-26898

RADIO RECEIVERS
Flight evaluation of GPS/DGPS sensor systems installed in NAL Do228
[NAL-TR-1230] p 382 N95-26585

RADIOMETERS
Data processing and mapping in airborne radiometric surveys
[HTN-95-51587] p 442 A95-83591

RADOMES
Mobile domes for TACTIC telescope
p 453 A95-86113

RAMJET ENGINES
Experiment of rocket-ram annular combustor
p 412 A95-82324

Transport phenomena and interfacial kinetics in multiphase combustion systems
[AD-A288297] p 418 N95-26417

Numerical simulation of combustion flow around a flame holder with hydrogen injection
[NAL-TR-1233] p 419 N95-26523

RANDOM LOADS
Stability of viscoelastic plate in supersonic flow under random loading
[BTN-95-EIX95262694312] p 435 A95-85483

RANGE (EXTREMES)
A comparison of measured wind park load histories with the WISPER and WISPERX load spectra
[DE95-000295] p 446 N95-27459

RARE GASES
Ignition analysis of hydrogen/air mixture in supersonic mixing layer
p 416 A95-82301

RAREFIED GASES
Rarefied gas numerical wind tunnel: OREX and HOPE
p 427 A95-82391

Rarefied gas effects on aerobraking/reentry vehicles with wakes
[NASA-CR-196586] p 415 N95-27093

RATINGS
Pilot rating scale for aircraft handling qualities
[HTN-95-42269] p 380 A95-84963

RAYLEIGH SCATTERING
Surface interference in Rayleigh scattering measurements near forebodies
[HTN-95-51670] p 433 A95-85052

REACTING FLOW
An experimental study on radiation from strong shock layer
p 368 A95-82421

REACTION KINETICS
Transport phenomena and interfacial kinetics in multiphase combustion systems
[AD-A288297] p 418 N95-26417

REAL TIME OPERATION
Design and synthesis of a real-time controller for an unmanned air vehicle
[AD-A289134] p 408 N95-26555

A study of workstation computational performance for real-time flight simulation
[NASA-TM-109184] p 449 N95-27241

Geophex airborne unmanned survey system
[DE95-007566] p 392 N95-27440

Design of a real-time wind turbine simulator using a custom parallel architecture
p 449 N95-27979

Control system design for the MOD-5A 7.3 mW wind turbine generator
p 440 N95-27985

REATTACHED FLOW
Reattachment studies of an oscillating airfoil dynamic stall flowfield
[HTN-95-51660] p 432 A95-85042

RECOMMENDATIONS
High-stakes aviation: US-Japan technology linkages in transport aircraft
[LC-94-65759] p 381 N95-27907

Report to Congressional Committees, Comanche Helicopter: Testing needs to be completed prior to production decisions
[GAO/NSIAD-95-112] p 397 N95-27910

REENTRY EFFECTS
An experimental study on radiation from strong shock layer
p 368 A95-82421

REENTRY RANGE
Reentry analysis for low Earth orbiting spacecraft
p 415 A95-85774

REENTRY SHIELDING
Reentry technology experiment on the first mission of reentry capsule 'EXPRESS'
p 414 A95-82499

REENTRY VEHICLES

REENTRY VEHICLES

VSL analysis of hypersonic flows around a reentry vehicle with equilibrium air chemistry p 413 A95-82400

Reentry technology experiment on the first mission of reentry capsule 'EXPRESS' p 414 A95-82499

REGRESSION ANALYSIS

Subharmonic and quasi-periodic motions of an eccentric squeeze film damper-mounted rigid rotor [BTN-94-EIX95011440601] p 429 A95-82982

REINFORCED SHELLS

Load transfer in the stiffener-to-skin joints of a pressurized fuselage [NASA-CR-198610] p 439 N95-27865

REINFORCEMENT (STRUCTURES)

Development and flight results of fiber reinforced balloon p 384 A95-82511

Recent progress in NASA Langley textile reinforced composites program p 425 N95-28475

REINFORCING FIBERS

Development and flight results of fiber reinforced balloon p 384 A95-82511

Ceramic composite attachments for transmission of high-torque loads [BTN-94-EIX95011441256] p 417 A95-84213

Composite repair of metallic airframe: Twenty years of experience p 393 N95-27508

Application of advanced material systems to composite frame elements p 422 N95-28432

Comparison of resin film infusion, resin transfer molding, and consolidation of textile preforms for primary aircraft structure p 425 N95-28477

Fundamental concepts in the suppression of delamination buckling by stitching p 426 N95-28486

REINFORCING MATERIALS

Recent progress in NASA Langley textile reinforced composites program p 425 N95-28475

RELIABILITY ANALYSIS

The 1994 updated National Airspace System performance assessment for year 2005 [AD-A288652] p 380 N95-26485

Reliability analysis of composite structures p 423 N95-28441

RELIABILITY ENGINEERING

Reliability analysis of composite structures p 423 N95-28441

Probabilistic design of advanced composite structure p 424 N95-28443

Proof test methodology for composites p 424 N95-28445

RELIEF MAPS

Naval Aviation System TEAM mapping, charting, and geodesy handbook [AD-A288590] p 446 N95-26841

REMOTE CONTROL

Geophex airborne unmanned survey system [DE95-007566] p 392 N95-27440

REMOTE SENSING

Mapping of forest fire damages using imaging spectroscopy p 442 A95-83627

Cuts endanger airborne research --- NASA Ames Research Center Reorganization [HTN-95-20602] p 443 A95-84783

REMOTELY PILOTED VEHICLES

Design and synthesis of a real-time controller for an unmanned air vehicle [AD-A289134] p 408 N95-26555

Unmanned aerial vehicles, 1994 master plan [AD-A291628] p 398 N95-28411

REQUIREMENTS

European firms team on supersonic studies [HTN-95-42215] p 386 A95-84031

RESEARCH

The high speed civil transport and NASA's High Speed Research (HSR) program p 390 N95-26945

RESEARCH AIRCRAFT

A conceptual design of hypersonic research vehicle with subscale scramjet engine p 384 A95-82482

Flightpath synthesis and HUD scaling for V/STOL terminal area operations [NASA-TM-110348] p 383 N95-26587

RESEARCH AND DEVELOPMENT

Development of 70MW class superconducting generators [BTN-94-EIX95011440854] p 429 A95-82905

JPRS report: Science and technology. Central Eurasia [JPRS-UST-94-022] p 438 N95-27699

Collected papers on wind turbine technology [NASA-CR-195432] p 447 N95-27970

Research and Technology Objectives and Plans Summary (RTOPS) [NASA-TM-108574] p 453 N95-28002

JTEC/WTEC annual report and program summary: 1993/94 [NASA-CR-198563] p 454 N95-28038

RESEARCH FACILITIES

Preliminary results and research capabilities of a new jet facility at the University of Kansas p 412 N95-26951

A review of Australian and New Zealand investigations on aeronautical fatigue during the period Apr. 1993 - Mar. 1995 [AR-009-202] p 397 N95-27918

RESEARCH MANAGEMENT

Research and Technology Objectives and Plans Summary (RTOPS) [NASA-TM-108574] p 453 N95-28002

RESEARCH PROJECTS

A review of Australian and New Zealand investigations on aeronautical fatigue during the period Apr. 1993 - Mar. 1995 [AR-009-202] p 397 N95-27918

Collected papers on wind turbine technology [NASA-CR-195432] p 447 N95-27970

RESEARCH VEHICLES

Computational analysis of forebody tangential slot blowing on the high alpha research vehicle [NASA-CR-197754] p 389 N95-26591

Numerical simulation of the flow about the F-18 HARV at high angle of attack [NASA-CR-197755] p 374 N95-26735

RESIDUAL STRENGTH

Investigation of static and cyclic bearing failure mechanisms for GR/EP laminates p 422 N95-28427

RESIDUAL STRESS

The effects of surface modification on fretting fatigue in Ti alloy turbine components [HTN-95-61145] p 404 A95-84909

RESIDUES

Hardware cleanliness methodology and certification p 419 N95-27656

RESIN TRANSFER MOLDING

Development of a low-cost, modified resin transfer molding process using elastomeric tooling and automated preform fabrication p 420 N95-28268

Resin transfer molding of textile preforms for aircraft structural applications p 421 N95-28276

Development of stitched/RTM composite primary structures p 425 N95-28469

Test and analysis results for composite transport fuselage and wing structures p 398 N95-28470

Composite fuselage crown panel manufacturing technology p 399 N95-28474

Advanced textile applications for primary aircraft structures p 399 N95-28476

Comparison of resin film infusion, resin transfer molding, and consolidation of textile preforms for primary aircraft structure p 425 N95-28477

Characterization and manufacture of braided composites for large commercial aircraft structures p 426 N95-28478

RESINS

Composite repair of metallic airframe: Twenty years of experience p 393 N95-27508

Field repair materials for naval aircraft p 394 N95-27514

Development of stitched/RTM composite primary structures p 425 N95-28469

RESONANCE

Air resonance of hingeless rotor helicopters in trimmed forward flight [HTN-95-61075] p 369 A95-83659

REVERBERATION CHAMBERS

Photoacoustic chambers for studying solids and gases: Theory and practical examples [IFTR-39/1994] p 412 N95-26837

REYNOLDS EQUATION

Computational analysis of forebody tangential slot blowing on the high alpha research vehicle [NASA-CR-197754] p 389 N95-26591

REYNOLDS NUMBER

Instability of three-dimensional boundary layers due to streamline curvature [HTN-95-61070] p 430 A95-83654

Predicting stall and post-stall behavior of airfoils at low mach numbers [BTN-95-EIX95262694297] p 365 A95-85468

Effect of Reynolds number and turbulence on airfoil aerodynamics at -90-degree incidence [HTN-95-42320] p 370 A95-86149

Sphere wakes at moderate Reynolds numbers in a turbulent environment [HTN-95-42331] p 372 A95-86160

Comparative wind tunnel test at high Reynolds numbers of NACA 64 621 airfoils with two aileron configurations p 377 N95-27977

REYNOLDS STRESS

Development of a large-aspect-ratio rectangular turbulent free jet [HTN-95-42333] p 372 A95-86162

RIBS (SUPPORTS)

Convection heat transfer distributions over plates with square ribs from infrared thermography measurements [HTN-95-20713] p 435 A95-86603

RIGID ROTORS

Subharmonic and quasi-periodic motions of an eccentric squeeze film damper-mounted rigid rotor [BTN-94-EIX95011440601] p 429 A95-82982

Air resonance of hingeless rotor helicopters in trimmed forward flight [HTN-95-61075] p 369 A95-83659

Effect of squeeze film damper land geometry on damper performance [HTN-95-92247] p 434 A95-85291

RIGID STRUCTURES

Composite fuselage shell structures research at NASA Langley Research Center p 425 N95-28466

RIMS

Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics [NASA-TM-106685] p 416 N95-27434

RING STRUCTURES

Thermo-hydrodynamic solution of floating ring seals for high pressure compressors using the finite-element method [HTN-95-92246] p 433 A95-85290

RIVETED JOINTS

Fatigue of aircraft materials and structures p 387 A95-85894

RIVETING

Automatic riveting cell for commercial aircraft floor grid assembly [HTN-95-92309] p 365 A95-85353

ROBOTICS

Survey and implementation of commercial manual controllers for a generic telerobotics architecture [AD-A289215] p 449 N95-26990

ROBOTS

Aircraft stripping and painting [HTN-95-92311] p 365 A95-85355

ROCKET NOZZLES

Experiment of rocket-ram annular combustor p 412 A95-82324

ROLL

An investigation of the effects of pitch-roll (de)coupling on helicopter handling qualities [NASA-TM-110349] p 409 N95-26773

ROLLING CONTACT LOADS

Design and development of a test rig for the high frequency testing of rolling sleeve airsprings [DSTO-TN-0001] p 411 N95-26378

ROTARY STABILITY

Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics [NASA-TM-106685] p 416 N95-27434

Whirl plus tilt [DE95-007948] p 452 N95-28108

ROTARY WING AIRCRAFT

Intelligent flight trainer for initial rotary wing training [SAE PAPER 932536] p 386 A95-84558

Vibration analysis of a split path gearbox [NASA-TM-106875] p 438 N95-27855

Evaluation of a doubly-swept blade tip for rotorcraft noise reduction [NASA-CR-189677] p 452 N95-28264

Application of advanced material systems to composite frame elements p 422 N95-28432

Rotorcraft crashworthy airframe and fuel system technology development program [AD-A289986] p 382 N95-28630

ROTARY WINGS

A higher harmonic control test in the DNW to reduce impulsive BVI noise [HTN-95-61071] p 385 A95-83655

Effects of blade tip shape on dynamics, cost, weight, aerodynamic performance, and aeroelastic response [HTN-95-61074] p 369 A95-83658

An analytical model for a nonlinear elastomeric lag damper and its effect on aeromechanical stability in Hover [HTN-95-61076] p 369 A95-83660

Considerations in the development of the coupled rotor fuselage model [HTN-95-61077] p 370 A95-83661

Fast Floquet theory and trim for multi-bladed rotorcraft [HTN-95-61078] p 370 A95-83662

Fast Floquet theory and trim for multi-bladed rotorcraft [HTN-95-61078] p 370 A95-83662

Torsional actuation with extension-torsion composite coupling and a magnetostrictive actuator [BTN-95-EIX95262694314] p 435 A95-85485

An experimental investigation of helicopter downwash and tailboom interaction at the Wichita State University 7x10 foot wind tunnel p 375 N95-26955

- Flow structure generated by perpendicular blade vortex interaction and implications for helicopter noise predictions
[NASA-CR-198590] p 377 N95-28193
- Aeroelasticity and structural optimization of composite helicopter rotor blades with swept tips
[NASA-CR-4665] p 397 N95-28262
- Evaluation of a doubly-swept blade tip for rotorcraft noise reduction
[NASA-CR-189677] p 452 N95-28264
- Nonlinear dynamics and aeroelasticity of rotorcraft in forward flight
[AD-A291714] p 400 N95-28504
- Modeling helicopter blade dynamics using a modified Myklestad-Prohl transfer matrix method
[AD-A289891] p 400 N95-28626
- ROTATING BODIES**
- Vibration measurements on rotating machinery using laser Doppler velocimetry
[BTN-94-EIX95011440597] p 429 A95-82986
- Transition correlations in three-dimensional boundary layers
[HTN-95-51648] p 432 A95-85030
- ROTATING SHAFTS**
- Use of blade pitch control to provide power train damping for the Mod-2, 2.5-mW wind turbine p 440 N95-27986
- ROTATION**
- Whirl plus tilt
[DE95-007948] p 452 N95-28108
- Modeling helicopter blade dynamics using a modified Myklestad-Prohl transfer matrix method
[AD-A289891] p 400 N95-28626
- ROTOR AERODYNAMICS**
- Vortex methods for the computational analysis of rotor/body interaction
[HTN-95-61072] p 369 A95-83656
- Considerations in the development of the coupled rotor fuselage model
[HTN-95-61077] p 370 A95-83661
- Fast Floquet theory and trim for multi-bladed rotorcraft
[HTN-95-61078] p 370 A95-83662
- Aircraft noise prediction program theoretical manual: Rotorcraft System Noise Prediction System (ROTONET), part 4
[NASA-TM-83199-PT-4] p 451 N95-26392
- Development and validation of a blade-element mathematical model for the AH-64A Apache helicopter
[NASA-TM-108863] p 367 N95-26710
- Preliminary analysis of dynamic stall effects on a 91-meter wind turbine rotor p 376 N95-27975
- ROTOR BLADES (TURBOMACHINERY)**
- Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics
[NASA-TM-106685] p 416 N95-27434
- Preliminary analysis of dynamic stall effects on a 91-meter wind turbine rotor p 376 N95-27975
- Comparative wind tunnel tests of NACA 23024 airfoils with several aileron and spoiler configurations p 376 N95-27976
- ROTOR BODY INTERACTIONS**
- Vortex methods for the computational analysis of rotor/body interaction
[HTN-95-61072] p 369 A95-83656
- Air resonance of hingeless rotor helicopters in trimmed forward flight
[HTN-95-61075] p 369 A95-83659
- Considerations in the development of the coupled rotor fuselage model
[HTN-95-61077] p 370 A95-83661
- ROTOR DYNAMICS**
- A higher harmonic control test in the DNW to reduce impulsive BVI noise
[HTN-95-61071] p 385 A95-83655
- Vortex methods for the computational analysis of rotor/body interaction
[HTN-95-61072] p 369 A95-83656
- An analytical model for a nonlinear elastomeric lag damper and its effect on aeromechanical stability in Hover
[HTN-95-61076] p 369 A95-83660
- Considerations in the development of the coupled rotor fuselage model
[HTN-95-61077] p 370 A95-83661
- Fast Floquet theory and trim for multi-bladed rotorcraft
[HTN-95-61078] p 370 A95-83662
- The dynamic nature of rotor thermal bending due to unsteady lubricant shearing within a bearing
[HTN-95-42091] p 430 A95-83857
- GETRAN: A generic, modularly structured computer code for simulation of dynamic behavior of aero- and power generation gas turbine engines
[BTN-94-EIX95011441241] p 431 A95-84198
- Aircraft noise prediction program theoretical manual: Rotorcraft System Noise Prediction System (ROTONET), part 4
[NASA-TM-83199-PT-4] p 451 N95-26392
- Development and validation of a blade-element mathematical model for the AH-64A Apache helicopter
[NASA-TM-108863] p 367 N95-26710
- Stall precursor study of high frequency data for three high speed, swept compressor rotors
[AD-A289379] p 406 N95-26878
- Whirl plus tilt
[DE95-007948] p 452 N95-28108
- Modeling helicopter blade dynamics using a modified Myklestad-Prohl transfer matrix method
[AD-A289891] p 400 N95-28626
- ROTORS**
- The dynamic nature of rotor thermal bending due to unsteady lubricant shearing within a bearing
[HTN-95-42091] p 430 A95-83857
- Optimization of wave rotors for use as gas turbine engine topping cycles
[NASA-TM-106951] p 406 N95-27860
- Comparative wind tunnel tests of NACA 23024 airfoils with several aileron and spoiler configurations p 376 N95-27976
- Whirl plus tilt
[DE95-007948] p 452 N95-28108
- RUDDERS**
- Numerical analysis of flow field around gas rudder
[NASA-TM-106886] p 407 A95-82333
- RUN TIME (COMPUTERS)**
- Design of a real-time wind turbine simulator using a custom parallel architecture p 449 N95-27979
- RUNGE-KUTTA METHOD**
- Accuracy and efficiency assessments for a weak statement CFD algorithm for high-speed aerodynamics
[BTN-94-EIX95011441238] p 370 A95-84195
- Parallel block implicit integration technique for trajectory parallelism
[AD-A288961] p 450 N95-28335
- Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils
[NASA-TP-3496] p 378 N95-28674
- RUNWAYS**
- Precision landing system mathematical modeling study report for Andrews Air Force Base, runway 19L, Camp Springs, MD
[AD-A289015] p 384 N95-27903
- RUSSIAN FEDERATION**
- JPRS report: Science and technology. Central Eurasia
[JPRS-UST-94-022] p 438 N95-27699
- S**
- S MATRIX THEORY**
- Hybrid finite element-modal analysis of jet engine inlet scattering
[BTN-95-EIX95242673665] p 427 A95-82259
- SAFETY MANAGEMENT**
- Human factors issues in aircraft cabin design
[SAE PAPER 932527] p 386 A95-84556
- SANDWICH STRUCTURES**
- Composite repair issues on the CF-18 aircraft
[HTN-95-61072] p 369 A95-83656
- External patch repair of CFRP/honeycomb sandwich
[HTN-95-61072] p 369 A95-83656
- Application of fiber-reinforced bismaleimide materials to aircraft nacelle structures p 397 N95-28278
- SATELLITE OBSERVATION**
- Air truth validation of cloud albedo estimated from NOAA advanced very high resolution radiometer data
[HTN-95-A1021] p 443 A95-84526
- An in situ evaluation of TOPEX/Poseidon altimetric measurements versus measurements made by moorings and inverted echo sounders for sea surface height
[NASA-CR-198621] p 447 N95-27805
- SATELLITE ORBITS**
- Determining GPS average performance metrics
[HTN-95-61072] p 369 A95-83656
- SATELLITE TRACKING**
- Flight Mechanics/Estimation Theory Symposium 1995
[NASA-CP-3299] p 416 N95-27763
- Determining GPS average performance metrics
[HTN-95-61072] p 369 A95-83656
- SCALE MODELS**
- Comparative wind tunnel tests of NACA 23024 airfoils with several aileron and spoiler configurations p 376 N95-27976
- SCHEDULES**
- A hybrid vehicle evaluation code and its application to vehicle design. Revision 1
[DE95-008053] p 441 N95-28029
- A hybrid vehicle evaluation code and its application to vehicle design, revision 2
[DE95-008060] p 441 N95-28139
- SCHEDULING**
- A gain scheduling optimization method using genetic algorithms
[AD-A289306] p 448 N95-26920
- SCHLIEREN PHOTOGRAPHY**
- Visualization of the multiple supersonic jet oscillations by swept focused strobed schlieren technique p 367 N95-26952
- SEA LEVEL**
- An in situ evaluation of TOPEX/Poseidon altimetric measurements versus measurements made by moorings and inverted echo sounders for sea surface height
[NASA-CR-198621] p 447 N95-27805
- SEALS (STOPPERS)**
- Thermo-hydrodynamic solution of floating ring seals for high pressure compressors using the finite-element method
[HTN-95-92246] p 433 A95-85290
- Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics
[NASA-TM-106685] p 416 N95-27434
- Numerical analysis of intra-cavity and power-stream flow interaction in multiple gas-turbine disk-cavities
[NASA-TM-106886] p 407 N95-28344
- SECONDARY FLOW**
- Turbomachinery design and tonal acoustics computations
[NASA-CR-197749] p 406 N95-26777
- Numerical analysis of intra-cavity and power-stream flow interaction in multiple gas-turbine disk-cavities
[NASA-TM-106886] p 407 N95-28344
- SELF EXCITATION**
- Nonlinear dynamics and aeroelasticity of rotorcraft in forward flight
[AD-A291714] p 400 N95-28504
- SEPARATED FLOW**
- Reattachment studies of an oscillating airfoil dynamic stall flowfield
[HTN-95-51660] p 432 A95-85042
- Crossflow topology of vortical flows
[HTN-95-51664] p 432 A95-85046
- Demonstration study of hierarchical control of fluid-dynamic phenomena
[AD-A289341] p 437 N95-26751
- Performance characterization of a highly-offset diffuser with and without blowing vortex generator jets
[AD-A289334] p 375 N95-26901
- SEQUENCING**
- A comparison of measured wind park load histories with the WISPER and WISPERX load spectra
[DE95-000295] p 446 N95-27459
- SERVOMECHANISMS**
- Design and synthesis of a real-time controller for an unmanned air vehicle
[AD-A289134] p 408 N95-26555
- SEWING**
- Development of stitched/RTM composite primary structures p 425 N95-28469
- Test and analysis results for composite transport fuselage and wing structures p 398 N95-28470
- SHAPE MEMORY ALLOYS**
- SMART materials: Surfaces, transforms and interfaces. The commensurate engineering dimension
[AD-A289598] p 442 N95-28649
- SHAPES**
- Effects of blade tip shape on dynamics, cost, weight, aerodynamic performance, and aeroelastic response
[HTN-95-61074] p 369 A95-83658
- Variational principles for ascent shapes of large scientific balloons
[BTN-95-EIX95262694320] p 387 A95-85491
- SHARP LEADING EDGES**
- Compressible inviscid vortex flow of a sharp edge delta wing
[BTN-95-EIX95262694308] p 370 A95-85479
- SHEAR FLOW**
- Prediction of two-dimensional momentumless wake by k-epsilon-gamma model
[BTN-95-EIX95262694299] p 434 A95-85470
- High angle-of-attack airfoil performance improvement by internal acoustic excitation
[HTN-95-42347] p 372 A95-86176
- Basic studies in turbulent shear flows
[AD-A289145] p 437 N95-26998
- SHEAR LAYERS**
- Near field of a coaxial jet with and without axial excitation
[HTN-95-42332] p 372 A95-86161
- SHEAR STRENGTH**
- Scar joint technique with cocured and precured patches for composite repair p 396 N95-27524
- SHEAR STRESS**
- Shear buckling response of tailored composite plates
[HTN-95-51680] p 418 A95-85062
- SHELLS (STRUCTURAL FORMS)**
- Composite fuselage shell structures research at NASA Langley Research Center p 425 N95-28466
- SHIPS**
- Tie-down trials involving a Sikorsky S-70B-2 helicopter
[DSTO-TR-0132] p 400 N95-28567

SHOCK LAYERS

SHOCK LAYERS

VSL analysis of hypersonic flows around a reentry vehicle with equilibrium air chemistry

p 413 A95-82400

An experimental study on radiation from strong shock layer

p 368 A95-82421

Viscous shock-layer analysis on hypersonic flow over reentry capsule with nonequilibrium chemistry

[ISAS-656] p 436 N95-26739

SHOCK MEASURING INSTRUMENTS

Micro-time stress measurement device development

[AD-A289511] p 448 N95-26845

SHOCK TUBES

An investigation of the AFIT 2-inch shock tube as a flow source for supersonic testing

[AD-A289246] p 412 N95-26966

SHOCK WAVE INTERACTION

A study on aerodynamic heating phenomena in three-dimensional shock wave/turbulent boundary layer interaction induced by sweptback sharp fins at supersonic flow

p 428 A95-82419

Compressible inviscid vortex flow of a sharp edge delta wing

[BTN-95-EIX95262694308] p 370 A95-85479

A numerical study of fundamental shock noise mechanisms

[NASA-TM-110608] p 451 N95-27908

Response of multi-panel assembly to noise from a jet in forward motion

[NASA-CR-198164] p 442 N95-28673

SHOCK WAVE PROPAGATION

A numerical study of fundamental shock noise mechanisms

[NASA-TM-110608] p 451 N95-27908

SHOCK WAVES

Prediction of pre-combustion shock in scramjet combustors: A new method

p 402 A95-82323

The aerodynamic characteristics of cup-like body in supersonic flow

p 427 A95-82407

Numerical simulation of unsteady aerodynamic heating induced by shock reflections

p 428 A95-82418

A study on aerodynamic heating phenomena in three-dimensional shock wave/turbulent boundary layer interaction induced by sweptback sharp fins at supersonic flow

p 428 A95-82419

Hypersonic flow simulation with thermoelectric effect

p 368 A95-82669

Flowfield measurements in supersonic film cooling including the effect of shock-wave interaction

[HTN-95-42337] p 405 A95-86166

An investigation of the AFIT 2-inch shock tube as a flow source for supersonic testing

[AD-A289246] p 412 N95-26966

A numerical study of fundamental shock noise mechanisms

[NASA-TM-110608] p 451 N95-27908

SHORT RANGE BALLISTIC MISSILES

The short range attack missile/light weight exo-atmospheric projectile (SRAM/LEAP) missile tests program

[HTN-95-81498] p 386 A95-85212

SIGNAL ANALYSIS

Speech analysis and synthesis based on pitch-synchronous segmentation of the speech waveform

[AD-A288824] p 435 N95-26349

Bearing defect signature analysis using advanced nonlinear signal analysis in a controlled environment

[NASA-TM-108491] p 441 N95-28364

SIGNATURE ANALYSIS

Bearing defect signature analysis using advanced nonlinear signal analysis in a controlled environment

[NASA-TM-108491] p 441 N95-28364

SIKORSKY AIRCRAFT

Report to Congressional Committees. Comanche Helicopter: Testing needs to be completed prior to production decisions

[GAO/NSIAD-95-112] p 397 N95-27910

Tie-down trials involving a Sikorsky S-70B-2 helicopter

[DSTO-TR-0132] p 400 N95-28567

SILICONES

Hardware cleanliness methodology and certification

p 419 N95-27656

SIMULATION

Studies on gain performance of a combustion driven CO₂ gas dynamic laser

p 428 A95-82679

The near-wake flow behavior of an oscillating airfoil with modified trailing edge

p 375 N95-26953

Advanced formation flight control

[AD-A289271] p 409 N95-26981

A hybrid vehicle evaluation code and its application to vehicle design. Revision 1

[DE95-008053] p 441 N95-28029

A hybrid vehicle evaluation code and its application to vehicle design, revision 2

[DE95-008060] p 441 N95-28139

SIMULATORS

Study on a scheme for the prolongation of microgravity time of balloon-borne drop capsule

p 414 A95-82515

SIMULTANEOUS EQUATIONS

An easy way to analyze longitudinal and lateral-directional trim problems with AEO or OEI

p 409 N95-26949

SKIN (STRUCTURAL MEMBER)

On aircraft repair verification of a fighter A/C integrally stiffened fuselage skin

p 394 N95-27515

SKY BRIGHTNESS

A mathematical analysis of the Janus combat simulation weather effects models and sensitivity analysis of sky-to-ground brightness ratio on target detection

[AD-A289629] p 446 N95-26858

SLEEVES

Design and development of a test rig for the high frequency testing of rolling sleeve airsprings

[DSTO-TN-0001] p 411 N95-26378

SLENDER BODIES

Crossflow topology of vortical flows

[HTN-95-51664] p 432 A95-85046

SLIDING

Prediction of fatigue crack growth under constant amplitude and random loading using specimens with multiple cracks

[AD-A291614] p 397 N95-28409

SLOTS

Computational analysis of forebody tangential slot blowing on the high alpha research vehicle

[NASA-CR-197754] p 389 N95-26591

SMART STRUCTURES

SMART materials: Surfaces, transforms and interfaces. The commensurate engineering dimension

[AD-A289598] p 442 N95-28649

SOFIA (AIRBORNE OBSERVATORY)

Numerical simulation of the SOFIA flow field

[NASA-CR-197757] p 436 N95-26589

SOFTWARE DEVELOPMENT TOOLS

An evaluation of the Software Through Pictures/T Tool (SiP/T) for the Software Support Activity (SSA)

[AD-A288822] p 447 N95-26348

SOFTWARE ENGINEERING

An evaluation of the Software Through Pictures/T Tool (SiP/T) for the Software Support Activity (SSA)

[AD-A288822] p 447 N95-26348

A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines

p 439 N95-27980

Control system design for the MOD-5A 7.3 mW wind turbine generator

p 440 N95-27985

Operator modeling in commercial aviation: Cognitive models, intelligent displays, and pilot's assistants

[NASA-CR-198609] p 401 N95-28203

Unmanned aerial vehicles, 1994 master plan

[AD-A291628] p 398 N95-28411

Software process improvement in the NASA software engineering laboratory

[AD-A289912] p 450 N95-28627

SOLIDS

Photoacoustic chambers for studying solids and gases: Theory and practical examples

[IFTR-39/1994] p 412 N95-26837

SONIC BOOMS

Design and testing of low sonic boom configurations and an oblique all-wing supersonic transport

[NASA-CR-197744] p 389 N95-26651

Supersonic civil airplane study and design: Performance and sonic boom

[NASA-CR-197745] p 390 N95-26813

SOUND DETECTING AND RANGING

Aircraft IR/acoustic detection evaluation. Volume 2: Development of a ground-based acoustic sensor system for the detection of subsonic jet-powered aircraft

[NASA-CR-189705-VOL-2] p 452 N95-28073

SOUND FIELDS

Stochastic approach to noise modeling for free turbulent flows

[HTN-95-42321] p 371 A95-86150

Acoustic field in unsteady moving media

[NASA-CR-198162] p 438 N95-27179

SOUND GENERATORS

A numerical study of fundamental shock noise mechanisms

[NASA-TM-110608] p 451 N95-27908

SOUND PRESSURE

Numerical simulation of the SOFIA flow field

[NASA-CR-197757] p 436 N95-26589

Observed acoustic and aeroelastic spectral responses of a MOD-2 turbine blade to turbulence excitation

p 451 N95-27991

Anechoic wind tunnel study of turbulence effects on wind turbine broadband noise

p 451 N95-27992

SOUND TRANSDUCERS

Aircraft IR/acoustic detection evaluation. Volume 2: Development of a ground-based acoustic sensor system for the detection of subsonic jet-powered aircraft

[NASA-CR-189705-VOL-2] p 452 N95-28073

SOUND WAVES

Transonic flutter suppression using active acoustic excitations

[BTN-95-EIX95262694310] p 408 A95-85481

Nonreflective boundary conditions for high-order methods

[HTN-95-42328] p 371 A95-86157

Observed acoustic and aeroelastic spectral responses of a MOD-2 turbine blade to turbulence excitation

p 451 N95-27991

Anechoic wind tunnel study of turbulence effects on wind turbine broadband noise

p 451 N95-27992

SOUNDING

An in situ evaluation of TOPEX/Poseidon altimetric measurements versus measurements made by moorings and inverted echo sounders for sea surface height

[NASA-CR-198621] p 447 N95-27805

SPACE NAVIGATION

Flight Mechanics/Estimation Theory Symposium 1995 [NASA-CP-3299] p 416 N95-27763

SPACE SHUTTLES

NAL aerothermodynamic probing and CFD verification mission in OREX experiment

p 368 A95-82413

SPACECRAFT BREAKUP

Reentry analysis for low Earth orbiting spacecraft

p 415 A95-85774

SPACECRAFT CONSTRUCTION MATERIALS

R & D on HOPE structure

p 413 A95-82355

SPACECRAFT CONTROL

Air data sensors for atmospheric reentry flight test of winged space vehicle

p 413 A95-82412

SPACECRAFT DESIGN

R & D on HOPE structure

p 413 A95-82355

JPRS report: Science and technology. Central Eurasia [JPRS-UST-94-022] p 438 N95-27699

SPACECRAFT ORBITS

How 'HITEN's' aerobraking experiments were carried out

p 415 A95-82553

SPACECRAFT REENTRY

Air data sensors for atmospheric reentry flight test of winged space vehicle

p 413 A95-82412

NAL aerothermodynamic probing and CFD verification mission in OREX experiment

p 368 A95-82413

Hypersonic thermal protection with mass injection at angle of attack

p 414 A95-82414

Hypersonic flow simulation with thermoelectric effect

p 368 A95-82669

Reentry analysis for low Earth orbiting spacecraft

p 415 A95-85774

Viscous shock-layer analysis on hypersonic flow over reentry capsule with nonequilibrium chemistry

[ISAS-656] p 436 N95-26739

Rarefied gas effects on aerobraking/reentry vehicles with wakes

[NASA-CR-196586] p 415 N95-27093

SPACECRAFT SHIELDING

Research and development of thermal protection system of HOPE re-entry vehicle

p 413 A95-82358

SPACECRAFT STRUCTURES

R & D on HOPE structure

p 413 A95-82355

SPACECRAFT TRACKING

Flight Mechanics/Estimation Theory Symposium 1995 [NASA-CP-3299] p 416 N95-27763

SPANWISE BLOWING

Study of potential aerodynamic benefits from spanwise blowing at wingtip

[NASA-TP-3515] p 378 N95-28669

SPARK IGNITION

Aircraft fuel system lightning protection design and qualification test procedures development

[AD-A288401] p 380 N95-26497

SPATIAL DISTRIBUTION

Fractal properties of whitecaps

[HTN-95-92121] p 443 A95-83827

SPECIFICATIONS

International cooperation in standardization

p 452 A95-82665

SPECTRUM ANALYSIS

An experimental study on radiation from strong shock layer

p 368 A95-82421

SPEECH RECOGNITION

Speech analysis and synthesis based on pitch-synchronous segmentation of the speech waveform

[AD-A288824] p 435 N95-26349

SPEED CONTROL

Scheduling of local nonlinear control laws by exogenous signals - an application to flight control

[BTN-95-EIX95262694059] p 447 A95-85675

SPEED REGULATORS

Variable speed generator application on the MOD-5A
7.3 mW wind turbine generator p 440 N95-27989

SPHERES

Sphere wakes at moderate Reynolds numbers in a
turbulent environment
[HTN-95-42331] p 372 A95-86160

SPOILER SLOTAILERONS

Comparative wind tunnel tests of NACA 23024 airfoils
with several aileron and spoiler configurations
p 376 N95-27976

SPRINGS (ELASTIC)

An analytical model for a nonlinear elastomeric lag
damper and its effect on aeromechanical stability in
Hover
[HTN-95-61076] p 369 A95-83660
Analysis techniques for the prediction of springback in
formed and bonded composite components
p 421 N95-28289

SPUTTERING

Permanent magnet electron cyclotron resonance
plasma source with remote window
[BTN-95-EIX95242674338] p 450 A95-82176

SQUEEZE FILMS

Subharmonic and quasi-periodic motions of an eccentric
squeeze film damper-mounted rigid rotor
[BTN-94-EIX95011440601] p 429 A95-82982
Effect of squeeze film damper land geometry on damper
performance
[HTN-95-92247] p 434 A95-85291

STABILITY

Observation of traveling waves in the three-dimensional
boundary layer along a yawed cylinder
[HTN-95-61064] p 430 A95-83648

STABILITY TESTS

Flight control design using mixed H2/micron
optimization
[AD-A289288] p 410 N95-27036

STABILIZERS (FLUID DYNAMICS)

Composite repair of a CF18: Vertical stabilizer leading
edge p 395 N95-27517
NASA-ACEE/Boeing 737 graphite-epoxy horizontal
stabilizer service p 400 N95-28489

STAGNATION FLOW

Numerical investigation of cylinder wake flow with a rear
stagnation jet
[HTN-95-51669] p 433 A95-85051

STAINLESS STEELS

Mechanism of deposit formation on fuel-wetted hot metal
surfaces
[AD-A289847] p 426 N95-28621

STANDARDIZATION

International cooperation in standardization
p 452 A95-82665
A comparison of measured wind park load histories with
the WISPER and WISPERX load spectra
[DE95-000295] p 446 N95-27459
The development of an engineering standard for
composite repairs p 396 N95-27528

STANDARDS

International cooperation in standardization
p 452 A95-82665

STATIC AERODYNAMIC CHARACTERISTICS

Reliability analysis of composite structures
p 423 N95-28441

STATIC CHARACTERISTICS

Effects of floor location on response of composite
fuselage frames p 423 N95-28439

STATIC ELECTRICITY

The effect of aviation fuels containing low amounts of
static dissipater additive on electrostatic charge
generation
[AD-A280075] p 420 N95-28152

STATIC LOADS

Investigation of static and cyclic bearing failure
mechanisms for GR/EP laminates p 422 N95-28427

STATIC TESTS

Experimental investigation of static and dynamic ground
effect on HOPE ALFLEX vehicle
[NAL-TR-1236] p 388 N95-26525
On aircraft repair verification of a fighter A/C integrally
stiffened fuselage skin p 394 N95-27515
External patch repair of CFRP/honeycomb sandwich
p 395 N95-27522
Static and fatigue testing of full-scale fuselage panels
fabricated using a Therm-X(R) process
p 420 N95-28270
Development of composite carrythrough bulkhead
p 423 N95-28438

STATISTICAL ANALYSIS

Probabilistic material strength degradation model for
Inconel 718 components subjected to high temperature,
high-cycle and low-cycle mechanical fatigue, creep and
thermal fatigue effects
[NASA-CR-197832] p 419 N95-27167

Calculation of design load for the MOD-5A 7.3 mW wind
turbine system p 440 N95-27982
Reliability analysis of composite structures
p 423 N95-28441

The performance of cargo airdrop systems using g-12E
parachutes: Statistical determination of minimum altitude
[AD-A291666] p 381 N95-28454

STEERING

Aircraft nosewheel steering simulation
p 412 N95-26944

STIFFENING

Fatigue of aircraft materials and structures
p 387 A95-85894

STIFFNESS

Damage tolerance of a geodesically stiffened advanced
composite structural concept for aircraft structural
applications p 399 N95-28487

STOCHASTIC PROCESSES

Stochastic approach to noise modeling for free
turbulent flows
[HTN-95-42321] p 371 A95-86150
A NASTRAN-based computer program for structural
dynamic analysis of Horizontal Axis Wind Turbines
p 439 N95-27980

STOVL AIRCRAFT

Simulation model of the integrated flight/propulsion
control system, displays, and propulsion system for
ASTOVL lift-fan aircraft
[NASA-TM-108866] p 405 N95-26412

STOWAGE (ONBOARD EQUIPMENT)

Tie-down trials involving a Sikorsky S-70B-2 helicopter
[DSTO-TR-0132] p 400 N95-28567

STRAIN ENERGY METHODS

Evaluation of patch effectiveness in repairing aircraft
components p 394 N95-27513

STRAIN ENERGY RELEASE RATE

Analysis of composite structures with delaminations
under combined bending and compression
p 422 N95-28429

STRAIN MEASUREMENT

SMART materials: Surfaces, transforms and interfaces.
The commensurate engineering dimension
[AD-A289598] p 442 N95-28649

STRAIN RATE

Technology integration box beam failure study
p 441 N95-28468

STRATOCUMULUS CLOUDS

Air truth validation of cloud albedo estimated from NOAA
advanced very high resolution radiometer data
[HTN-95-A1021] p 443 A95-84526

STRATOSPHERE

Effects of a polar stratosphere cloud parameterization
on ozone depletion due to stratospheric aircraft in a
two-dimensional model
[HTN-95-A1038] p 443 A95-84543
An overview of the EASOE campaign
[HTN-95-00702] p 443 A95-86272
Aircraft measurements of CLO and HCL during EASOE
1991/92
[HTN-95-00721] p 444 A95-86291
An overview of millimeter-wave spectroscopic
measurements of chlorine monoxide at Thule, Greenland,
February-March, 1992: Vertical profiles, diurnal variation,
and longer-term trends
[HTN-95-00722] p 444 A95-86292
Two dimensional stratospheric aerosol distributions
during EASOE
[HTN-95-00726] p 444 A95-86296
Airborne lidar observation of mountain-wave-induced
polar stratospheric clouds during EASOE
[HTN-95-00738] p 444 A95-86308
Airborne measurements during the European Arctic
Stratospheric Ozone Experiment: Observation of OClO
[HTN-95-00745] p 445 A95-86315
Airborne measurements during the Arctic stratospheric
experiment: Observation of O3 and NO2
[HTN-95-00748] p 445 A95-86318
Replicator for characterization of cirrus and polar
stratospheric cloud particles
[NASA-CR-197785] p 445 N95-26669

STRATUS CLOUDS

Air truth validation of cloud albedo estimated from NOAA
advanced very high resolution radiometer data
[HTN-95-A1021] p 443 A95-84526

STRESS ANALYSIS

Stress considerations in reduced-size aeroelastic
optimization
[BTN-95-EIX95262694313] p 366 A95-85484
Design and structural validation of CF116 upper wing
skin boron doubler p 393 N95-27510
Evaluation of patch effectiveness in repairing aircraft
components p 394 N95-27513

Repair technology for thermoplastic aircraft structures
p 395 N95-27519

Scarf repairs to graphite/epoxy components
p 396 N95-27523

Damage occurrence on composites during testing and
fleet service: Repair of Airbus aircraft
p 396 N95-27526

Reliability analysis of composite structures
p 423 N95-28441

STRESS CONCENTRATION

Tension fracture of laminates for transport fuselage. Part
1: Material screening p 398 N95-28471

STRESS DISTRIBUTION

Tension fracture of laminates for transport fuselage. Part
1: Material screening p 398 N95-28471

STRESS-STRAIN DIAGRAMS

Non-linear viscoelastic-plastic constitutive relations for
an aeronautical PMMA
[HTN-95-71132] p 385 A95-83493

STRETCH FORMING

Application of advanced material systems to composite
frame elements p 422 N95-28432

STRINGERS

Load transfer in the stiffener-to-skin joints of a
pressurized fuselage
[NASA-CR-198610] p 439 N95-27865

STRIPPING

Aircraft stripping and painting
[HTN-95-92311] p 365 A95-85355

STRUCTURAL ANALYSIS

Shear buckling response of tailored composite plates
[HTN-95-51680] p 418 A95-85062
Equivalent beam-column analysis of guded towers
[BTN-95-EIX95262696644] p 435 A95-85519
A non-iterative grid deformation algorithm for
computational fluid dynamics for aeroelasticity
[AD-A288298] p 436 N95-26418
Bonded composite repair of metallic aircraft
components: Overview of Australian activities
p 392 N95-27505
Design and structural validation of CF116 upper wing
skin boron doubler p 393 N95-27510
Load transfer in the stiffener-to-skin joints of a
pressurized fuselage
[NASA-CR-198610] p 439 N95-27865
Aeroelasticity and structural optimization of composite
helicopter rotor blades with swept tips
[NASA-CR-4665] p 397 N95-28262
Static and fatigue testing of full-scale fuselage panels
fabricated using a Therm-X(R) process
p 420 N95-28270
Analysis techniques for the prediction of springback in
formed and bonded composite components
p 421 N95-28289

Investigation of static and cyclic bearing failure
mechanisms for GR/EP laminates p 422 N95-28427
Analysis of composite structures with delaminations
under combined bending and compression
p 422 N95-28429

Development of composite carrythrough bulkhead
p 423 N95-28438

Probabilistic evaluation of fuselage-type composite
structures p 398 N95-28444

Composite fuselage shell structures research at NASA
Langley Research Center p 425 N95-28466
Structural testing of the technology integration box
beam p 441 N95-28467

Development of stitched/RTM composite primary
structures p 425 N95-28469

Test and analysis results for composite transport
fuselage and wing structures p 398 N95-28470

STRUCTURAL DESIGN

Recent developments in nylon superpressure balloons
p 385 A95-82512

Development of 70MW class superconducting
generators
[BTN-94-EIX95011440854] p 429 A95-82905

Ceramic composite attachments for transmission of
high-torque loads
[BTN-94-EIX95011441256] p 417 A95-84213

Shear buckling response of tailored composite plates
[HTN-95-51680] p 418 A95-85062

Stress considerations in reduced-size aeroelastic
optimization
[BTN-95-EIX95262694313] p 366 A95-85484

Design and development of a test rig for the high
frequency testing of rolling sleeve airsprings
[DSTO-TN-0001] p 411 N95-26378

AIAA Techfest 20 Proceedings
[NIAR-94-1] p 367 N95-26941

Damage occurrence on composites during testing and
fleet service: Repair of Airbus aircraft
p 396 N95-27526

Load transfer in the stiffener-to-skin joints of a
pressurized fuselage
[NASA-CR-198610] p 439 N95-27865

Horizontal axis wind turbine post stall airfoil characteristics synthesis p 376 N95-27974
Calculation of design load for the MOD-5A 7.3 mW wind turbine system p 440 N95-27982
Whirl plus tilt p 452 N95-28108
[DE95-007948]
Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 3
[NASA-CR-198718] p 420 N95-28266
Development of a low-cost, modified resin transfer molding process using elastomeric tooling and automated preform fabrication p 420 N95-28268
Resin transfer molding of textile preforms for aircraft structural applications p 421 N95-28276
Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 1
[NASA-CR-198723] p 421 N95-28420
Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 2
[NASA-CR-198722] p 424 N95-28462
Overview of the ACT program p 424 N95-28463
Development of stitched/RTM composite primary structures p 425 N95-28469
Recent progress in NASA Langley textile reinforced composites program p 425 N95-28475
Damage tolerance of a geodesically stiffened advanced composite structural concept for aircraft structural applications p 399 N95-28487

STRUCTURAL DESIGN CRITERIA
Mobile domes for TACTIC telescope p 453 A95-86113
Structural design optimization with survivability dependent constraints application: Primary wing box of a multi-role fighter p 398 N95-28440

STRUCTURAL ENGINEERING
Probabilistic evaluation of fuselage-type composite structures p 398 N95-28444
COINS: A composites information database system p 453 N95-28465

STRUCTURAL FAILURE
Design and structural validation of CF116 upper wing skin boron doubler p 393 N95-27510
Repair technology for thermoplastic aircraft structures p 395 N95-27519
Applications of a damage tolerance analysis methodology in aircraft design and production p 426 N95-28483
Numerical simulation of crack growth in pressurized fuselages
[PB95-192415] p 400 N95-28636

STRUCTURAL MEMBERS
Comparison of resin film infusion, resin transfer molding, and consolidation of textile preforms for primary aircraft structure p 425 N95-28477

STRUCTURAL RELIABILITY
Reliability analysis of composite structures p 423 N95-28441
Probabilistic design of advanced composite structure p 424 N95-28443

STRUCTURAL STABILITY
Stability of viscoelastic plate in supersonic flow under random loading
[BTN-95-EIX95262694312] p 435 A95-85483
Aeroelastic stability of wind turbine blade/aileron systems p 377 N95-27981

STRUCTURAL VIBRATION
Subharmonic and quasi-periodic motions of an eccentric squeeze film damper-mounted rigid rotor
[BTN-94-EIX95011440601] p 429 A95-82982
Vibration measurements on rotating machinery using laser Doppler velocimetry
[BTN-94-EIX95011440597] p 429 A95-82986
Interaction of jet noise with a nearby panel assembly
[BTN-95-EIX95262694295] p 434 A95-85466
Vibration analysis of a split path gearbox
[NASA-TM-106875] p 438 N95-27855

STRUCTURAL WEIGHT
Structural design optimization with survivability dependent constraints application: Primary wing box of a multi-role fighter p 398 N95-28440

SUBSONIC FLOW
Direct boundary integral equations method to subsonic flow with circulation past thin airfoils in ground effect
[BTN-95-EIX95242673940] p 365 A95-82224
Interaction of jet noise with a nearby panel assembly
[BTN-95-EIX95262694295] p 434 A95-85466
A fixed time performance evaluation of parallel CFD applications
[DE94-014240] p 436 N95-26445
TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual
[NASA-CR-4349] p 377 N95-28230

TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document
[NASA-CR-4348] p 378 N95-28265
Response of multi-panel assembly to noise from a jet in forward motion
[NASA-CR-198164] p 442 N95-28673

SUBSONIC SPEED
Airfoil modification effects on subsonic and transonic pressure distributions and performance for the EA-6B airplane
[NASA-TP-3516] p 373 N95-26382
Performance characterization of a highly-offset diffuser with and without blowing vortex generator jets
[AD-A289334] p 375 N95-26901
A general theory of two- and three-dimensional rotational flow in subsonic and transonic turbomachines
[NASA-CR-4496] p 377 N95-28003
Measurements of store forces and moments and cavity pressures for a generic store in and near a box cavity at subsonic and transonic speeds
[NASA-TM-4611] p 378 N95-28241
Study of potential aerodynamic benefits from spanwise blowing at wingtip
[NASA-TP-3515] p 378 N95-28669
Noise exposure reduction of advanced high-lift systems
[NASA-CR-195077] p 452 N95-28670
Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils
[NASA-TP-3496] p 378 N95-28674

SULFUR HEXAFLUORIDE
Stationary premixed flames in spherical and cylindrical geometries
[HTN-95-42336] p 418 A95-86165
Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils
[NASA-TP-3496] p 378 N95-28674

SULFUR OXIDES
Evolution of the concentrations of trace species in an aircraft plume: Trajectory study
[HTN-95-A1044] p 443 A95-84549

SUPERCOMPUTERS
NAS Technical Summaries, March 1993 - February 1994
[NASA-RP-1355] p 453 N95-27367

SUPERCONDUCTING DEVICES
Development of 70MW class superconducting generators
[BTN-94-EIX95011440854] p 429 A95-82905

SUPERCONDUCTING POWER TRANSMISSION
Development of 70MW class superconducting generators
[BTN-94-EIX95011440854] p 429 A95-82905

SUPERCONDUCTORS (MATERIALS)
Development of 70MW class superconducting generators
[BTN-94-EIX95011440854] p 429 A95-82905

SUPERSONIC AIRCRAFT
Aircraft gas turbine emissions challenge
[BTN-94-EIX95011441239] p 403 A95-84196

SUPERSONIC BOUNDARY LAYERS
Surface interference in Rayleigh scattering measurements near forebodies
[HTN-95-51670] p 433 A95-85052

SUPERSONIC COMBUSTION
Ignition analysis of hydrogen/air mixture in supersonic mixing layer p 416 A95-82301
Prediction of pre-combustion shock in scramjet combustors: A new method p 402 A95-82323

SUPERSONIC COMBUSTION RAMJET ENGINES
Design features of the NAL ramjet engine test facility p 410 A95-82319
Hypersonic wind tunnel test of sidewall compression type scramjet inlet p 410 A95-82320
Evaluation of scramjet nozzle performance p 402 A95-82321
An experimental investigation of scramjet nozzle flow p 402 A95-82322
Prediction of pre-combustion shock in scramjet combustors: A new method p 402 A95-82323
An advanced scramjet propulsion concept for A 350 MG SSTO space plane p 402 A95-82325
Hypersonic trajectory control of aerospace plane with integrated SCRAMJET engine p 413 A95-82384
Experiment and analysis on heat transfer of a scramjet leading edge model p 403 A95-82420
A conceptual design of hypersonic research vehicle with subscale scramjet engine p 384 A95-82482
Studies on plasma jet igniters p 403 A95-82680
Experiment on a rectangular cross section scramjet combustor. 2: Effects of fuel injector geometry
[NAL-TR-1220] p 405 N95-26600

Effects of dust from storage heaters on ignition in scramjets p 405 N95-26706
[NAL-TR-1234]
Experimental investigation of inlet-combustor isolators for a dual-mode scramjet at a Mach number of 4
[NASA-TP-3502] p 407 N95-28343

SUPERSONIC COMMERCIAL AIR TRANSPORT
European firms team on supersonic studies
[HTN-95-42215] p 386 A95-84031

SUPERSONIC FLOW
The aerodynamic characteristics of cup-like body in supersonic flow p 427 A95-82407
A study on aerodynamic heating phenomena in three-dimensional shock wave/turbulent boundary layer interaction induced by sweptback sharp fins at supersonic flow p 428 A95-82419
Accuracy and efficiency assessments for a weak statement CFD algorithm for high-speed aerodynamics
[BTN-94-EIX95011441238] p 370 A95-84195
Computational/experimental investigation of staged injection into a Mach 2 flow p 432 A95-85028
Stability of viscoelastic plate in supersonic flow under random loading
[BTN-95-EIX95262694312] p 435 A95-85483
Flowfield measurements in supersonic film cooling including the effect of shock-wave interaction
[HTN-95-42337] p 405 A95-86166
A fixed time performance evaluation of parallel CFD applications
[DE94-014240] p 436 N95-26445
Wind tunnel experiments on wake flow field behind a reentry capsule from a viewpoint of parachute deployment at supersonic speeds
[ISAS-655] p 374 N95-26740
Development of an upwind, finite-volume code with finite-rate chemistry
[NASA-CR-197747] p 374 N95-26760
An investigation of the AFIT 2-inch shock tube as a flow source for supersonic testing
[AD-A289246] p 412 N95-26966
A laboratory scale supersonic combustive flow system
[DE95-006347] p 420 N95-27851
TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual
[NASA-CR-4349] p 377 N95-28230
TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document
[NASA-CR-4348] p 378 N95-28265

SUPERSONIC JET FLOW
Structure of supersonic jet flow and its radiated sound
[HTN-95-51645] p 431 A95-85027
Screch tones from free and ducted supersonic jets
[HTN-95-51647] p 432 A95-85029
Quantitative investigation of compressible mixing: Staged transverse injection into Mach 2 flow
[HTN-95-42330] p 404 A95-86159
Supersonic coaxial jet noise predictions
[NASA-TM-106917] p 451 N95-26801
Preliminary results and research capabilities of a new jet facility at the University of Kansas p 412 N95-26951
Visualization of the multiple supersonic jet oscillations by swept focused strobed schlieren technique p 367 N95-26952
A numerical study of fundamental shock noise mechanisms
[NASA-TM-110608] p 451 N95-27908

SUPERSONIC NOZZLES
Evaluation of scramjet nozzle performance p 402 A95-82321

SUPERSONIC SPEED
An investigation of the AFIT 2-inch shock tube as a flow source for supersonic testing
[AD-A289246] p 412 N95-26966
Experimental investigation of inlet-combustor isolators for a dual-mode scramjet at a Mach number of 4
[NASA-TP-3502] p 407 N95-28343

SUPERSONIC TRANSPORTS
Supersonic transport grid generation, validation, and optimization
[NASA-CR-197752] p 448 N95-26648
CFD research, parallel computation and aerodynamic optimization
[NASA-CR-197748] p 373 N95-26649
Design and testing of low sonic boom configurations and an oblique all-wing supersonic transport
[NASA-CR-197744] p 389 N95-26651
Supersonic civil airplane study and design: Performance and sonic boom
[NASA-CR-197745] p 390 N95-26813

Preliminary design problems and solutions for a supersonic oblique all-wing transport aircraft
p 390 N95-26942

The high speed civil transport and NASA's High Speed Research (HSR) program
p 390 N95-26945

SUPERSONIC TURBINES
Turbomachinery design and tonal acoustics computations
[NASA-CR-197749]
p 406 N95-26777

SUPERSONIC WAKES
Wind tunnel experiments on wake flow field behind a reentry capsule from a viewpoint of parachute deployment at supersonic speeds
[ISAS-655]
p 374 N95-26740

SUPERSONIC WIND TUNNELS
Quiet-flow Ludwig tube for high-speed transition research
[BTN-95-EIX95262694309]
p 370 A95-85480

Computational support of the laminar flow supersonic wind tunnel, CNSFV code development, Maglev, and grid generation
[NASA-CR-197750]
p 411 N95-26775

A laboratory scale supersonic combustive flow system
[DE95-006347]
p 420 N95-27851

SUPPORTS
Tie-down trials involving a Sikorsky S-70B-2 helicopter
[DSTO-TR-0132]
p 400 N95-28567

SUPPRESSORS
Suppressor of oscillations in airframe cavities
[AD-D017265]
p 388 N95-26507

SURFACE ROUGHNESS
The effects of wall perturbations on thermo-turbulent Couette flow
[HTN-95-92255]
p 434 A95-85299

Constant flux, turbulent convection data using infrared imaging
[HTN-95-20731]
p 435 A95-86621

SURFACE TREATMENT
The effects of surface modification on fretting fatigue in Ti alloy turbine components
[HTN-95-61145]
p 404 A95-84909

Aircraft stripping and painting
[HTN-95-92311]
p 365 A95-85355

SURVEYS
Survey and implementation of commercial manual controllers for a generic telerobotics architecture
[AD-A289215]
p 449 N95-26990

Geophex airborne unmanned survey system
[DE95-007566]
p 392 N95-27440

SWEEP EFFECT
Evaluation of a doubly-swept blade tip for rotorcraft noise reduction
[NASA-CR-189677]
p 452 N95-28264

SWEEPBACK
A study on aerodynamic heating phenomena in three-dimensional shock wave/turbulent boundary layer interaction induced by sweptback sharp fins at supersonic flow
p 428 A95-82419

SWEPT WINGS
Multiple instabilities of three-dimensional boundary layers along a concave wall
[HTN-95-71126]
p 429 A95-83487

Study of potential aerodynamic benefits from spanwise blowing at wingtip
[NASA-TP-3515]
p 378 N95-28669

SWINGBY TECHNIQUE
How 'HITEN's' aerobraking experiments were carried out
p 415 A95-82553

SYSTEM EFFECTIVENESS
Assessment of cost and training effectiveness for a candidate training system using the Comparison-Based Prediction model
[SAE PAPER 932598]
p 379 A95-84570

SYSTEMS ANALYSIS
Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system
p 440 N95-27983

Variable speed generator application on the MOD-5A 7.3 mW wind turbine generator
p 440 N95-27989

SYSTEMS ENGINEERING
Ceramic composite attachments for transmission of high-torque loads
[BTN-94-EIX95011441256]
p 417 A95-84213

Aircraft fuel system lightning protection design and qualification test procedures development
[AD-A288401]
p 380 N95-26497

Design and synthesis of a real-time controller for an unmanned air vehicle
[AD-A289134]
p 408 N95-26555

Calculation of design load for the MOD-5A 7.3 mW wind turbine system
p 440 N95-27982

Unmanned aerial vehicles, 1994 master plan
[AD-A291628]
p 398 N95-28411

SYSTEMS STABILITY

Development of 70MW class superconducting generators
[BTN-94-EIX95011440854]
p 429 A95-82905

T**T-56 ENGINE**

Characteristics of the turbine inlet temperature sensing circuit for the T56 turbo-prop engine
[DSTO-TR-0095]
p 405 N95-26424

TABLES (DATA)

Enplanement and all cargo activity
[AD-A280074]
p 412 N95-28151

TAIL ASSEMBLIES

F/A-18 FOSTP Fatigue test airbag load determination on the vertical and horizontal tails
[DSTO-TR-0135]
p 388 N95-26389

Numerical simulation of the SOFIA flow field
[NASA-CR-197757]
p 436 N95-26589

Application of damage tolerance methodology in certification of the Piaggio P-180 Avanti
p 399 N95-28480

TARGET ACQUISITION

A mathematical analysis of the Janus combat simulation weather effects models and sensitivity analysis of sky-to-ground brightness ratio on target detection
[AD-A289629]
p 446 N95-26858

Classification of ultra high range resolution radar using decision boundary analysis
[AD-A289378]
p 437 N95-26877

Aircraft IR/acoustic detection evaluation. Volume 2: Development of a ground-based acoustic sensor system for the detection of subsonic jet-powered aircraft
[NASA-CR-189705-VOL-2]
p 452 N95-28073

TARGET RECOGNITION

Classification of ultra high range resolution radar using decision boundary analysis
[AD-A289378]
p 437 N95-26877

TARGETS

Permanent magnet electron cyclotron resonance plasma source with remote window
[BTN-95-EIX95242674338]
p 450 A95-82176

Classification of ultra high range resolution radar using decision boundary analysis
[AD-A289378]
p 437 N95-26877

TAYLOR INSTABILITY

Instability of three-dimensional boundary layers due to streamline curvature
[HTN-95-61070]
p 430 A95-83654

TDR SATELLITES

Flight Mechanics/Estimation Theory Symposium 1995
[NASA-CP-3299]
p 416 N95-27763

TECHNOLOGY ASSESSMENT

Applying nanostructured materials to future gas turbine engines
[HTN-95-11909]
p 404 A95-85990

Asian Aeronautics: Technology acquisition drives industry development. Report to Congressional requesters
[GAO/NSIAD-94-140]
p 367 N95-26817

A review of falconry as a bird control technique with recommendations for use at the Shuttle Landing Facility, John F. Kennedy Space Center, Florida, USA
[NASA-TM-110142]
p 381 N95-27859

Propulsion system assessment for very high UAV under ERAT
[NASA-CR-195469]
p 406 N95-27866

High-stakes aviation: US-Japan technology linkages in transport aircraft
[LC-94-65759]
p 381 N95-27907

JTEC/WTEC annual report and program summary: 1993/94
[NASA-CR-198563]
p 454 N95-28038

Navy composite maintenance and repair experience
p 424 N95-28446

Composite fuselage crown panel manufacturing technology
p 399 N95-28474

TECHNOLOGY TRANSFER

High-stakes aviation: US-Japan technology linkages in transport aircraft
[LC-94-65759]
p 381 N95-27907

Collected papers on wind turbine technology
[NASA-CR-195432]
p 447 N95-27970

TECHNOLOGY UTILIZATION

Integrated mission precision attack cockpit technology (IMPACT). Phase 1: Identifying technologies for air-to-ground fighter integration
[AD-A289562]
p 389 N95-26684

Utilization of composite materials by the US Army: A look ahead
p 421 N95-28421

TELEROBOTICS

Survey and implementation of commercial manual controllers for a generic telerobotics architecture
[AD-A289215]
p 449 N95-26990

TELESCOPES

Numerical simulation of the SOFIA flow field
[NASA-CR-197757]
p 436 N95-26589

TEMPERATURE CONTROL

Characteristics of the turbine inlet temperature sensing circuit for the T56 turbo-prop engine
[DSTO-TR-0095]
p 405 N95-26424

CAE for thermal management of aerospace electronic boards using the BETAsoft program
p 438 N95-27354

TEMPERATURE DEPENDENCE

A model for temperature-dependent collisional quenching of OH A(sup 2) Sigma(sup +)
[HTN-95-42308]
p 450 A95-85002

TEMPERATURE DISTRIBUTION

Convection heat transfer distributions over plates with square ribs from infrared thermography measurements
[HTN-95-20713]
p 435 A95-86603

TEMPERATURE EFFECTS

The dynamic nature of rotor thermal bending due to unsteady lubricant shearing within a bearing
[HTN-95-42091]
p 430 A95-83857

Pressure and temperature distortion testing of a two-stage centrifugal compressor
[BTN-94-EIX95011441250]
p 431 A95-84207

The noise reduction potential of dual-stream coaxial rectangular improperly expanded jet flows
[NASA-CR-197820]
p 437 N95-26995

Probabilistic material strength degradation model for Inconel 718 components subjected to high temperature, high-cycle and low-cycle mechanical fatigue, creep and thermal fatigue effects
[NASA-CR-197832]
p 419 N95-27167

Bonded composite repair of thin metallic materials: Variable load amplitude and temperature cycling effects
p 393 N95-27509

Repair of high temperature composite aircraft structure
p 395 N95-27520

Scarf joint technique with cocured and precured patches for composite repair
p 396 N95-27524

TEMPERATURE MEASUREMENT

Constant flux, turbulent convection data using infrared imaging
[HTN-95-20731]
p 435 A95-86621

Characteristics of the turbine inlet temperature sensing circuit for the T56 turbo-prop engine
[DSTO-TR-0095]
p 405 N95-26424

TEMPERATURE MEASURING INSTRUMENTS

Micro-time stress measurement device development
[AD-A289511]
p 448 N95-26845

TEMPERATURE PROFILES

Contribution of thermal radiation to the temperature profile of ceramic composite materials
[BTN-94-EIX95011441252]
p 417 A95-84209

TEMPERATURE SENSORS

Characteristics of the turbine inlet temperature sensing circuit for the T56 turbo-prop engine
[DSTO-TR-0095]
p 405 N95-26424

TENSILE PROPERTIES

Tension fracture of laminates for transport fuselage. Part 1: Material screening
p 398 N95-28471

TENSILE STRENGTH

Status of bonded boron/epoxy doublers for military and commercial aircraft structures
p 393 N95-27506

TENSILE STRESS

Composite repair issues on the CF-18 aircraft
p 395 N95-27518

TENSILE TESTS

On aircraft repair verification of a fighter A/C integrally stiffened fuselage skin
p 394 N95-27515

TERMINAL GUIDANCE

Nonlinear observer and its application in flight control
p 447 A95-82449

TERRAIN FOLLOWING

Part-task simulator evaluations of advanced terrain displays
[SAE PAPER 932570]
p 401 A95-84567

TEST CHAMBERS

Study on a scheme for the prolongation of microgravity time of balloon-borne drop capsule
p 414 A95-82515

NASA Lewis Research Center's combustor test facilities and capabilities
[NASA-TM-106903]
p 412 N95-27176

Two-phase flow research using the learjet apparatus
[NASA-TM-106814]
p 438 N95-27854

NASA Dryden flow visualization facility
[NASA-TM-4631]
p 449 N95-27914

TEST FACILITIES

Stall precursor study of high frequency data for three high speed, swept compressor rotors
[AD-A289379]
p 406 N95-26878

NASA Lewis Research Center's combustor test facilities and capabilities
[NASA-TM-106903]
p 412 N95-27176

TEST PILOTS

TEST PILOTS

- Pilot rating scale for aircraft handling qualities
[HTN-95-42269] p 380 A95-84963

TEST STANDS

- Design and development of a test rig for the high frequency testing of rolling sleeve airsprings
[DSTO-TN-0001] p 411 N95-26378

TEXTILES

- Recent progress in NASA Langley textile reinforced composites program p 425 N95-28475
Advanced textile applications for primary aircraft structures p 399 N95-28476

TEXTS

- The controller memory guide. Concepts from the field
[AD-A289263] p 383 N95-26978

THEORIES

- Horizontal axis wind turbine post stall airfoil characteristics synthesis p 376 N95-27974

THERMAL ANALYSIS

- Experiment and analysis on heat transfer of a scramjet leading edge model p 403 A95-82420
CAE for thermal management of aerospace electronic boards using the BETAsoft program p 438 N95-27354

THERMAL CONTROL COATINGS

- Study on the turbine vane and blade for a 1500 C class industrial gas turbine
[BTN-94-EIX95011441254] p 431 A95-84211

THERMAL CYCLING TESTS

- Composite repair of metallic airframe: Twenty years of experience p 393 N95-27508
Bonded composite repair of thin metallic materials: Variable load amplitude and temperature cycling effects p 393 N95-27509

THERMAL FATIGUE

- Probabilistic material strength degradation model for Inconel 718 components subjected to high temperature, high-cycle and low-cycle mechanical fatigue, creep and thermal fatigue effects
[NASA-CR-197832] p 419 N95-27167

THERMAL PROTECTION

- Research and development of thermal protection system of HOPE re-entry vehicle p 413 A95-82358
Hypersonic thermal protection with mass injection at angle of attack p 414 A95-82414

THERMAL RADIATION

- Contribution of thermal radiation to the temperature profile of ceramic composite materials
[BTN-94-EIX95011441252] p 417 A95-84209

THERMAL STABILITY

- Field repair materials for naval aircraft p 394 N95-27514

THERMAL STRESSES

- Composite repair of metallic airframe: Twenty years of experience p 393 N95-27508

THERMOCOUPLES

- Characteristics of the turbine inlet temperature sensing circuit for the T56 turbo-prop engine
[DSTO-TR-0095] p 405 N95-26424
Process and control systems for composites manufacturing p 420 N95-28267

THERMODYNAMIC CYCLES

- Second-law analysis of vapor compression heat pumps with solution circuit
[BTN-94-EIX95011441236] p 431 A95-84193

THERMODYNAMIC EFFICIENCY

- Second-law analysis of vapor compression heat pumps with solution circuit
[BTN-94-EIX95011441236] p 431 A95-84193

THERMODYNAMICS

- Thermo-hydrodynamic solution of floating ring seals for high pressure compressors using the finite-element method
[HTN-95-92246] p 433 A95-85290

THERMOELECTRICITY

- Hypersonic flow simulation with thermoelectric effect p 368 A95-82669

THERMOGRAPHY

- Convection heat transfer distributions over plates with square ribs from infrared thermography measurements
[HTN-95-20713] p 435 A95-86603

THERMOPLASTIC RESINS

- Analysis techniques for the prediction of springback in formed and bonded composite components p 421 N95-28289
Characterization and manufacture of braided composites for large commercial aircraft structures p 426 N95-28478
Advanced wing design survivability testing and results p 400 N95-28488

THERMOPLASTICITY

- Repair technology for thermoplastic aircraft structures p 395 N95-27519
ACT/ICAPS: Thermoplastic composite activities p 421 N95-28274

THESES

- Advanced formation flight control
[AD-A289271] p 409 N95-26981

THICKNESS

- Scarf repairs to graphite/epoxy components p 396 N95-27523

THIN WALLS

- Vibrational behavior of adaptive aircraft wing structures modelled as composite thin-walled beams p 423 N95-28435

THREE DIMENSIONAL BODIES

- Rarefied gas numerical wind tunnel: OREX and HOPE p 427 A95-82391
Development of an upwind, finite-volume code with finite-rate chemistry
[NASA-CR-197747] p 374 N95-26760

THREE DIMENSIONAL BOUNDARY LAYER

- Multiple instabilities of three-dimensional boundary layers along a concave wall
[HTN-95-71126] p 429 A95-83487
Observation of traveling waves in the three-dimensional boundary layer along a yawed cylinder
[HTN-95-61064] p 430 A95-83648
Instability of three-dimensional boundary layers due to streamline curvature
[HTN-95-61070] p 430 A95-83654
Transition correlations in three-dimensional boundary layers
[HTN-95-51648] p 432 A95-85030

THREE DIMENSIONAL FLOW

- Computational/experimental investigation of staged injection into a Mach 2 flow
[HTN-95-51646] p 432 A95-85028
Computational fluid dynamics and transonic flow
[AD-A288962] p 436 N95-26405
Effects of three-dimensional imposed 3-D disturbances on bluff-body near wake flows
[AD-A289553] p 374 N95-26757
Turbomachinery design and tonal acoustics computations
[NASA-CR-197749] p 406 N95-26777
Global flowfield about the V-22 Tiltrotor Aircraft
[NASA-CR-198603] p 375 N95-27248
Calculation of three-dimensional (3-D) internal flow by means of the velocity-vorticity formulation on a staggered grid
[NASA-TM-110352] p 376 N95-27258
A general theory of two- and three-dimensional rotational flow in subsonic and transonic turbomachines
[NASA-CR-4496] p 377 N95-28003
TransAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual
[NASA-CR-4349] p 377 N95-28230

THRUST

- Evaluation of scramjet nozzle performance p 402 A95-82321
Experiment of rocket-ram annular combustor p 412 A95-82324

THRUST VECTOR CONTROL

- Robust longitudinal axis flight control for an aircraft with thrust vectoring
[BTN-95-EIX95122538875] p 408 A95-83000

TILT WING AIRCRAFT

- Flying qualities development and flight simulation evaluation of the TW-68 tilt-wing VTOL aircraft
[SAE PAPER 932517] p 386 A95-84555

TIME LAG

- An analytical model for a nonlinear elastomeric lag damper and its effect on aeromechanical stability in Hover
[HTN-95-61076] p 369 A95-83660

TIME MARCHING

- Numerical investigation to S-inlet flows (Numerical simulation study of S-inlet flows)
[AD-A289590] p 374 N95-26713

TITANIUM ALLOYS

- The effects of surface modification on fretting fatigue in Ti alloy turbine components
[HTN-95-61145] p 404 A95-84909

TOLERANCES (MECHANICS)

- The analysis of the processing increased weight for pilot production of F-X aircraft
[HTN-95-71133] p 385 A95-83494
Verification of the damage tolerance of a fighter aircraft p 388 A95-85897
Tension fracture of laminates for transport fuselage. Part 1: Material screening p 398 N95-28471
Application of damage tolerance methodology in certification of the Piaggio P-180 Avanti p 399 N95-28480
Applications of a damage tolerance analysis methodology in aircraft design and production p 426 N95-28483

- Damage tolerance of a geodesically stiffened advanced composite structural concept for aircraft structural applications p 399 N95-28487

TOPOGRAPHY

- Effect of squeeze film damper land geometry on damper performance
[HTN-95-92247] p 434 A95-85291
Naval Aviation System TEAM mapping, charting, and geodesy handbook
[AD-A288590] p 446 N95-26841
Airborne geophysics and precise positioning: Scientific issues and future directions
[LC-94-68678] p 446 N95-27156

TOPOLOGY

- Crossflow topology of vortical flows
[HTN-95-51664] p 432 A95-85046

TOPPING CYCLE ENGINES

- Optimization of wave rotors for use as gas turbine engine topping cycles
[NASA-TM-106951] p 406 N95-27860

TORQUE

- Ceramic composite attachments for transmission of high-torque loads
[BTN-94-EIX95011441256] p 417 A95-84213
Whirl plus tilt
[DE95-007948] p 452 N95-28108

TORSIONAL STRESS

- Torsional actuation with extension-torsion composite coupling and a magnetostrictive actuator
[BTN-95-EIX95262694314] p 435 A95-85485

TOTAL ENERGY SYSTEMS

- Development of a TECS control-law for the lateral directional axis of the McDonnell Douglas F-15 Eagle
[AD-A289771] p 410 N95-28598

TOWED BODIES

- Wind-tunnel tests of an inclined cylinder having helical grooves
[BTN-95-EIX95262694306] p 411 A95-85477

TOWERS

- Equivalent beam-column analysis of guyed towers
[BTN-95-EIX95262696644] p 435 A95-85519

TRACE CONTAMINANTS

- Evolution of the concentrations of trace species in an aircraft plume: Trajectory study
[HTN-95-A1044] p 443 A95-84549

TRAILING EDGE FLAPS

- Torsional actuation with extension-torsion composite coupling and a magnetostrictive actuator
[BTN-95-EIX95262694314] p 435 A95-85485

TRAILING EDGES

- Explicit Kutta condition for an unsteady two-dimensional constant potential panel method
[HTN-95-51679] p 433 A95-85061
Airfoil modification effects on subsonic and transonic pressure distributions and performance for the EA-6B airplane
[NASA-TP-3516] p 373 N95-26382
The near-wake flow behavior of an oscillating airfoil with modified trailing edge p 375 N95-26953

TRAINING DEVICES

- Assessment of cost and training effectiveness for a candidate training system using the Comparison-Based Prediction model
[SAE PAPER 932598] p 379 A95-84570

TRAINING EVALUATION

- Automated hover training: An empirical evaluation
[SAE PAPER 932536] p 379 A95-84559

TRAINING SIMULATORS

- Education, training, and human engineering in aerospace: SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993
[SAE SP-992] p 417 A95-84553
Neuro-controllers for adaptive helicopter training
[SAE PAPER 932535] p 379 A95-84557
Intelligent flight trainer for initial rotary wing training
[SAE PAPER 932536] p 386 A95-84558
Automated hover training: An empirical evaluation
[SAE PAPER 932536] p 379 A95-84559

TRAJECTORIES

- Optimal trajectories for hypersonic launch vehicles
[HTN-95-61120] p 415 A95-84884
The performance of cargo airdrop systems using g-12E parachutes: Statistical determination of minimum altitude
[AD-A291666] p 381 N95-28454

TRAJECTORY CONTROL

- Hypersonic trajectory control of aerospace plane with integrated SCRAMJET engine p 413 A95-82384

TRANSONIC COMPRESSORS

- A general theory of two- and three-dimensional rotational flow in subsonic and transonic turbomachines
[NASA-CR-4496] p 377 N95-28003

TRANSONIC FLOW

- An inverse design method of transonic airfoil and wing
[HTN-95-71128] p 385 A95-83489

Transonic flutter suppression using active acoustic excitations
[BTN-95-EIX95262694310] p 408 A95-85481

Computational analysis of buffet alleviation in viscous transonic flow over a porous airfoil
[BTN-95-EIX95262694321] p 366 A95-85492

Computational fluid dynamics and transonic flow
[AD-A288962] p 436 N95-26405

A numerical method for unsteady transonic flow about wings with control surfaces
[AD-A289631] p 375 N95-26859

A general theory of two- and three-dimensional rotational flow in subsonic and transonic turbomachines
[NASA-CR-4496] p 377 N95-28003

TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual
[NASA-CR-4349] p 377 N95-28230

TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document
[NASA-CR-4348] p 378 N95-28265

TRANSONIC FLUTTER
Transonic flutter suppression using active acoustic excitations
[BTN-95-EIX95262694310] p 408 A95-85481

TRANSONIC SPEED
Airfoil modification effects on subsonic and transonic pressure distributions and performance for the EA-6B airplane
[NASA-TP-3516] p 373 N95-26382

Measurements of store forces and moments and cavity pressures for a generic store in and near a box cavity at subsonic and transonic speeds
[NASA-TM-4611] p 378 N95-28241

TRANSPORT AIRCRAFT
Effects of a polar stratosphere cloud parameterization on ozone depletion due to stratospheric aircraft in a two-dimensional model
[HTN-95-A1038] p 443 A95-84543

Evolution of the concentrations of trace species in an aircraft plume: Trajectory study
[HTN-95-A1044] p 443 A95-84549

Damage tolerance capability
p 388 A95-85898

Non-linear analysis provides new insights into impact damage of composite structures
[HTN-95-42368] p 418 A95-86197

Preliminary design problems and solutions for a supersonic oblique all-wing transport aircraft
p 390 N95-26942

Load transfer in the stiffener-to-skin joints of a pressurized fuselage
[NASA-CR-198610] p 439 N95-27865

High-stakes aviation: US-Japan technology linkages in transport aircraft
[LC-94-65759] p 381 N95-27907

Evaluation of all-electric secondary power for transport aircraft
[NASA-CR-189077] p 441 N95-27999

Overview of the ACT program
p 424 N95-28463

Designers' unified cost model
p 424 N95-28464

COINS: A composites information database system
p 453 N95-28465

Composite fuselage shell structures research at NASA Langley Research Center
p 425 N95-28466

Test and analysis results for composite transport fuselage and wing structures
p 398 N95-28470

TRANSPORT PROPERTIES
Transport phenomena and interfacial kinetics in multiphase combustion systems
[AD-A288297] p 418 N95-26417

TRANSPIRERS
Parallel block implicit integration technique for trajectory parallelism
[AD-A288961] p 450 N95-28335

TRAVELING WAVES
Observation of traveling waves in the three-dimensional boundary layer along a yawed cylinder
[HTN-95-61064] p 430 A95-83648

TRENDS
High-stakes aviation: US-Japan technology linkages in transport aircraft
[LC-94-65759] p 381 N95-27907

TRIBOLOGY
Thermo-hydrodynamic solution of floating ring seals for high pressure compressors using the finite-element method
[HTN-95-92246] p 433 A95-85290

Effect of squeeze film damper land geometry on damper performance
[HTN-95-92247] p 434 A95-85291

The effects of wall perturbations on thermo-turbulent Couette flow
[HTN-95-92255] p 434 A95-85299

TRUNCATION ERRORS

Precision requirement for potential-based panel methods
[HTN-95-51666] p 433 A95-85048

TURBINE BLADES

Boundary layer studies over an S-blade
[HTN-95-92261] p 434 A95-85305

A summary of computational experience at GE Aircraft Engines for complex turbulent flows in gas turbines
p 439 N95-27885

Comparative performance tests on the Mod-2, 2.5-mW wind turbine with and without vortex generators
p 377 N95-27978

Aeroelastic stability of wind turbine blade/aileron systems
p 377 N95-27981

Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system
p 440 N95-27983

Use of blade pitch control to provide power train damping for the Mod-2, 2.5-mW wind turbine
p 440 N95-27986

Observed acoustic and aeroelastic spectral responses of a MOD-2 turbine blade to turbulence excitation
p 451 N95-27991

TURBINE ENGINES

Ceramic composite combustor cans for expendable turbine engines
[AD-A289551] p 407 N95-28646

TURBINE PUMPS

Boundary layer studies over an S-blade
[HTN-95-92261] p 434 A95-85305

Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics
[NASA-TM-106685] p 416 N95-27434

TURBINE WHEELS

Preliminary analysis of dynamic stall effects on a 91-meter wind turbine rotor
p 376 N95-27975

Use of blade pitch control to provide power train damping for the Mod-2, 2.5-mW wind turbine
p 440 N95-27986

Variable speed generator application on the MOD-5A 7.3 mW wind turbine generator
p 440 N95-27989

TURBINES

A comparison of measured wind park load histories with the WISPER and WISPERX load spectra
[DE95-000295] p 446 N95-27459

TURBOCOMPRESSORS

Thermo-hydrodynamic solution of floating ring seals for high pressure compressors using the finite-element method
[HTN-95-92246] p 433 A95-85290

WINCLR: A computer code for heat transfer and clearance calculation in a compressor
[NASA-CR-195436] p 366 N95-26363

TURBOFAN ENGINES

Nitrogen oxide emissions characteristics of augmented turbofan engines
[BTN-94-EIX95011441240] p 403 A95-84197

GETRAN: A generic, modularly structured computer code for simulation of dynamic behavior of aero- and power generation gas turbine engines
[BTN-94-EIX95011441241] p 431 A95-84198

Control requirements for the RB 211 low-emission combustion system
[BTN-94-EIX95011441244] p 416 A95-84201

TURBOJET ENGINE CONTROL

Control requirements for the RB 211 low-emission combustion system
[BTN-94-EIX95011441244] p 416 A95-84201

TURBOJET ENGINES

Aircraft gas turbine emissions challenge
[BTN-94-EIX95011441239] p 403 A95-84196

Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics
[NASA-TM-106685] p 416 N95-27434

TURBOMACHINE BLADES

Study on the turbine vane and blade for a 1500 C class industrial gas turbine
[BTN-94-EIX95011441254] p 431 A95-84211

Aeroelastic stability of cascades in turbomachinery
[HTN-95-61156] p 405 A95-86255

TURBOMACHINERY

Aeroelastic stability of cascades in turbomachinery
[HTN-95-61156] p 405 A95-86255

A general theory of two- and three-dimensional rotational flow in subsonic and transonic turbomachines
[NASA-CR-4496] p 377 N95-28003

Bearing defect signature analysis using advanced nonlinear signal analysis in a controlled environment
[NASA-TM-108491] p 441 N95-28364

TURBOPROP ENGINES

Artificial intelligence for turboprop engine maintenance
[HTN-95-92313] p 404 A95-85357

TURBORAMJET ENGINES

Test results on air turbo ramjet engine for a future space plane
p 402 A95-82327

TURBULENCE

Prediction of two-dimensional momentumless wake by k-epsilon-gamma model
[BTN-95-EIX95262694299] p 434 A95-85470

Quantitative investigation of compressible mixing: Staged transverse injection into Mach 2 flow
[HTN-95-42330] p 404 A95-86159

Basic studies in turbulent shear flows
[AD-A289145] p 437 N95-26998

NAS Technical Summaries, March 1993 - February 1994
[NASA-RP-1355] p 453 N95-27367

Industry-Wide Workshop on Computational Turbulence Modeling
[NASA-CP-10165] p 439 N95-27882

TURBULENCE EFFECTS

Observed acoustic and aeroelastic spectral responses of a MOD-2 turbine blade to turbulence excitation
p 451 N95-27991

Anechoic wind tunnel study of turbulence effects on wind turbine broadband noise
p 451 N95-27992

TURBULENCE MODELS

Effect of Reynolds number and turbulence on airfoil aerodynamics at -90-degree incidence
[HTN-95-42320] p 370 A95-86149

Supersonic coaxial jet noise predictions
[NASA-TM-106917] p 451 N95-26801

Industry-Wide Workshop on Computational Turbulence Modeling
[NASA-CP-10165] p 439 N95-27882

A summary of computational experience at GE Aircraft Engines for complex turbulent flows in gas turbines
p 439 N95-27885

The applicability of turbulence models to aerodynamic and propulsion flowfields at McDonnell-Douglas Aerospace
p 439 N95-27886

Combustion system CFD modeling at GE Aircraft Engines
p 439 N95-27889

Measurement and prediction of broadband noise from large horizontal axis wind turbine generators
p 451 N95-27990

TURBULENT BOUNDARY LAYER

A study on aerodynamic heating phenomena in three-dimensional shock wave/turbulent boundary layer interaction induced by sweptback sharp fins at supersonic flow
p 428 A95-82419

The near-wake flow behavior of an oscillating airfoil with modified trailing edge
p 375 N95-26953

Measurement and prediction of broadband noise from large horizontal axis wind turbine generators
p 451 N95-27990

TURBULENT COMBUSTION

Combustion system CFD modeling at GE Aircraft Engines
p 439 N95-27889

TURBULENT FLOW

The effects of wall perturbations on thermo-turbulent Couette flow
[HTN-95-92255] p 434 A95-85299

Boundary layer studies over an S-blade
[HTN-95-92261] p 434 A95-85305

Stochastic approach to noise modeling for free turbulent flows
[HTN-95-42321] p 371 A95-86150

Sphere wakes at moderate Reynolds numbers in a turbulent environment
[HTN-95-42331] p 372 A95-86160

A review of the hot-wire technique in 2-D compressible flow
[HTN-95-61157] p 373 A95-86256

Plate manipulators
[AD-A289601] p 374 N95-26719

Basic studies in turbulent shear flows
[AD-A289145] p 437 N95-26998

A summary of computational experience at GE Aircraft Engines for complex turbulent flows in gas turbines
p 439 N95-27885

Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils
[NASA-TP-3496] p 378 N95-28674

TURBULENT HEAT TRANSFER
Constant flux, turbulent convection data using infrared imaging
[HTN-95-20731] p 435 A95-86621

TURBULENT JETS
Development of a large-aspect-ratio rectangular turbulent free jet
[HTN-95-42333] p 372 A95-86162

TURBULENT MIXING
Development of a large-aspect-ratio rectangular turbulent free jet
[HTN-95-42333] p 372 A95-86162

TURBULENT WAKES
Sphere wakes at moderate Reynolds numbers in a turbulent environment
[HTN-95-42331] p 372 A95-86160

TVD SCHEMES

TVD SCHEMES

- Numerical simulation of unsteady aerodynamic heating induced by shock reflections p 428 A95-82418
Development of an upwind, finite-volume code with finite-rate chemistry [NASA-CR-197747] p 374 N95-26760

TWO DIMENSIONAL BODIES

- Explicit Kutta condition for an unsteady two-dimensional constant potential panel method [HTN-95-51679] p 433 A95-85061

TWO DIMENSIONAL FLOW

- Numerical analysis of flow field around gas rudder p 407 A95-82333
Two-dimensional viscous flow past a flat plate [HTN-95-42210] p 430 A95-84026
Prediction of two-dimensional momentumless wake by k - ϵ - gamma model [BTN-95-EIX95262694299] p 434 A95-85470
A review of the hot-wire technique in 2-D compressible flow [HTN-95-61157] p 373 A95-86256
Numerical simulation of combustion flow around a flame holder with hydrogen injection [NAL-TR-1233] p 419 N95-26523
A general theory of two- and three-dimensional rotational flow in subsonic and transonic turbomachines [NASA-CR-4496] p 377 N95-28003

TWO DIMENSIONAL MODELS

- Effects of a polar stratosphere cloud parameterization on ozone depletion due to stratospheric aircraft in a two-dimensional model [HTN-95-A1038] p 443 A95-84543

TWO PHASE FLOW

- Study of heat transfer rates during quenching of a hot tube under microgravity p 428 A95-82641
Experimental investigation of flow-boiling heat transfer under microgravity p 428 A95-82642
Two-phase flow research using the learjet apparatus [NASA-TM-106814] p 438 N95-27854

U

UH-1 HELICOPTER

- The effects of UH-1 experience on UH-60 simulator performance: A preliminary study [AD-A289457] p 391 N95-26993

UKRAINE

- JPRS report: Science and technology. Central Eurasia [JPRS-UST-94-022] p 438 N95-27699

UNITED STATES

- Strategy in the commercial aircraft industry in the United States: A comparison of decisionmaking by McDonnell-Douglas and Boeing aircraft companies from 1977-1983 [AD-A288289] p 366 N95-26409
Comparison of fixed wing aircraft algorithms for JANUS [AD-A288503] p 389 N95-26652

UNMANNED SPACECRAFT

- A concept of a hypersonic flight experiment of a winged vehicle p 414 A95-82477
Reentry technology experiment on the first mission of reentry capsule 'EXPRESS' p 414 A95-82499

UNSTEADY AERODYNAMICS

- On the influence of time-varying flow velocity on unsteady aerodynamics [HTN-95-61073] p 369 A95-83657
Explicit Kutta condition for an unsteady two-dimensional constant potential panel method [HTN-95-51679] p 433 A95-85061
An experimental investigation of helicopter downwash and tailboom interaction at the Wichita State University 7x10 foot wind tunnel p 375 N95-26955
Modeling of aircraft unsteady aerodynamic characteristics. Part 2: Parameters estimated from wind tunnel data [NASA-TM-110161] p 410 N95-27839
A numerical study of fundamental shock noise mechanisms [NASA-TM-110608] p 451 N95-27908
Dynamic unstructured method for flows past multiple objects in relative motion [BTN-95-EIX95262694303] p 435 A95-85474
Turbomachinery design and tonal acoustics computations [NASA-CR-197749] p 406 N95-26777
A numerical method for unsteady transonic flow about wings with control surfaces [AD-A289631] p 375 N95-26859
Global flowfield about the V-22 Tiltrotor Aircraft [NASA-CR-198603] p 375 N95-27248
Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics [NASA-TM-106685] p 416 N95-27434

- A numerical study of fundamental shock noise mechanisms [NASA-TM-110608] p 451 N95-27908

UNSTEADY STATE

- Acoustic field in unsteady moving media [NASA-CR-198162] p 438 N95-27179

UNSTRUCTURED GRIDS (MATHEMATICS)

- Dynamic unstructured method for flows past multiple objects in relative motion [BTN-95-EIX95262694303] p 435 A95-85474
Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils [NASA-TP-3496] p 378 N95-28674

USER MANUALS (COMPUTER PROGRAMS)

- WINCLR: A computer code for heat transfer and clearance calculation in a compressor [NASA-CR-195436] p 366 N95-26363
Aircraft noise prediction program theoretical manual: Rotorcraft System Noise Prediction System (ROTONET), part 4 [NASA-TM-83199-PT-4] p 451 N95-26392
User documentation of the CTA program [AD-A289508] p 375 N95-26854
TransAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual [NASA-CR-4349] p 377 N95-28230

USER REQUIREMENTS

- The value of simulation for training [AD-A289174] p 411 N95-26556

V

V-22 AIRCRAFT

- Global flowfield about the V-22 Tiltrotor Aircraft [NASA-CR-198603] p 375 N95-27248
Navy composite maintenance and repair experience p 424 N95-28446

V/STOL AIRCRAFT

- Flightpath synthesis and HUD scaling for V/STOL terminal area operations [NASA-TM-110348] p 383 N95-26587

VALUE ENGINEERING

- An analysis of the KC-135 three-person cockpit [AD-A289540] p 390 N95-26873

VARIABLE AMPLITUDE LOADING

- Fatigue of aircraft materials and structures p 387 A95-85894
Bonded composite repair of thin metallic materials: Variable load amplitude and temperature cycling effects p 393 N95-27509

VARIATIONAL PRINCIPLES

- Variational principles for ascent shapes of large scientific balloons [BTN-95-EIX95262694320] p 387 A95-85491

VELOCITY DISTRIBUTION

- Instability of three-dimensional boundary layers due to streamline curvature [HTN-95-61070] p 430 A95-83654
Boundary layer studies over an S-blade [HTN-95-92261] p 434 A95-85305

VELOCITY MEASUREMENT

- Constant flux, turbulent convection data using infrared imaging [HTN-95-20731] p 435 A95-86621
Flutter clearance flight tests of an OV-10A airplane modified for wake vortex flight experiments [NASA-TM-109168] p 366 N95-26381
Calculation of three-dimensional (3-D) internal flow by means of the velocity-vorticity formulation on a staggered grid [NASA-TM-110352] p 376 N95-27258

VERTICAL DISTRIBUTION

- Aircraft measurements of CLO and HCL during EASOE 1991/92 [HTN-95-00721] p 444 A95-86291
An overview of millimeter-wave spectroscopic measurements of chlorine monoxide at Thule, Greenland, February-March, 1992: Vertical profiles, diurnal variation, and longer-term trends [HTN-95-00722] p 444 A95-86292
Airborne lidar observation of mountain-wave-induced polar stratospheric clouds during EASOE [HTN-95-00738] p 444 A95-86308
Airborne measurements during the European Arctic Stratospheric Ozone Experiment column amounts of HNO₃ and O₃ derived from FTIR emission sounding [HTN-95-00742] p 445 A95-86312

VERTICAL LANDING

- NASA-Lewis tests Allison ASTOVL nozzle [HTN-95-20603] p 404 A95-84784

VERTICAL TAKEOFF AIRCRAFT

- Flying qualities development and flight simulation evaluation of the TW-68 tilt-wing VTOL aircraft [SAE PAPER 932517] p 386 A95-84555
Design and synthesis of a real-time controller for an unmanned air vehicle [AD-A289134] p 408 N95-26555

VIBRATION

- Modeling helicopter blade dynamics using a modified Myklestad-Prohl transfer matrix method [AD-A289891] p 400 N95-28626

VIBRATION DAMPING

- Effect of squeeze film damper land geometry on damper performance [HTN-95-92247] p 434 A95-85291
Transonic flutter suppression using active acoustic excitations [BTN-95-EIX95262694310] p 408 A95-85481
Torsional actuation with extension-torsion composite coupling and a magnetostrictive actuator [BTN-95-EIX95262694314] p 435 A95-85485

VIBRATION EFFECTS

- Vibrational behavior of adaptive aircraft wing structures modelled as composite thin-walled beams p 423 N95-28435

VIBRATION ISOLATORS

- Effect of squeeze film damper land geometry on damper performance [HTN-95-92247] p 434 A95-85291

VIBRATION MEASUREMENT

- Vibration measurements on rotating machinery using laser Doppler velocimetry [BTN-94-EIX95011440597] p 429 A95-82986

VIBRATION METERS

- Vibration measurements on rotating machinery using laser Doppler velocimetry [BTN-94-EIX95011440597] p 429 A95-82986
Micro-time stress measurement device development [AD-A289511] p 448 N95-26845

VIBRATION MODE

- Stress considerations in reduced-size aeroelastic optimization [BTN-95-EIX95262694313] p 366 A95-85484
Aeroelastic stability of wind turbine blade/aileron systems p 377 N95-27981

VIEWING

- Advanced interactive display formats for terminal area traffic control [NASA-CR-198576] p 384 N95-28188

VIRTUAL REALITY

- The photo-realistic AFIT virtual cockpit [AD-A289376] p 390 N95-26876

VISCOELASTICITY

- Non-linear viscoelastic-plastic constitutive relations for an aeronautical PMMA [HTN-95-71132] p 385 A95-83493
An analytical model for a nonlinear elastomeric lag damper and its effect on aeromechanical stability in Hover [HTN-95-61076] p 369 A95-83660
Stability of viscoelastic plate in supersonic flow under random loading [BTN-95-EIX95262694312] p 435 A95-85483

VISCIOUS FLOW

- Two-dimensional viscous flow past a flat plate [HTN-95-42210] p 430 A95-84026
Computational analysis of buffet alleviation in viscous transonic flow over a porous airfoil [BTN-95-EIX95262694321] p 366 A95-85492
Effect of Reynolds number and turbulence on airfoil aerodynamics at -90-degree incidence [HTN-95-42320] p 370 A95-86149
General solution procedure for flows in local chemical equilibrium [HTN-95-42329] p 404 A95-86158
Development of an upwind, finite-volume code with finite-rate chemistry [NASA-CR-197747] p 374 N95-26760
Global flowfield about the V-22 Tiltrotor Aircraft [NASA-CR-198603] p 375 N95-27248
Calculation of three-dimensional (3-D) internal flow by means of the velocity-vorticity formulation on a staggered grid [NASA-TM-110352] p 376 N95-27258
Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils [NASA-TP-3496] p 378 N95-28674
VISUAL PERCEPTION
Characterization of corrosion and development of a breadboard of a D sight aircraft inspection system, phase 1 [AD-A288347] p 380 N95-26527

VOICE COMMUNICATION

- Speech analysis and synthesis based on pitch-synchronous segmentation of the speech waveform
[AD-A288824] p 435 N95-26349
- Development of a coding form for approach control/pilot voice communications
[DOT/FAA/AM-95/15] p 384 N95-28540

VOICE DATA PROCESSING

- Speech analysis and synthesis based on pitch-synchronous segmentation of the speech waveform
[AD-A288824] p 435 N95-26349

VOLCANOES

- Two dimensional stratospheric aerosol distributions during EASOE
[HTN-95-00726] p 444 A95-86296
- Airborne measurements during the Arctic stratospheric experiment: Observation of O3 and NO2
[HTN-95-00748] p 445 A95-86318

VORTEX BREAKDOWN

- Compressible inviscid vortex flow of a sharp edge delta wing
[HTN-95-EIX95262694308] p 370 A95-85479

VORTEX GENERATORS

- Mixing enhancement by and noise characteristics of streamwise vortices in an air jet
[HTN-95-42322] p 371 A95-86151
- Performance characterization of a highly-offset diffuser with and without blowing vortex generator jets
[AD-A289334] p 375 N95-26901
- Collected papers on wind turbine technology
[NASA-CR-195432] p 447 N95-27970
- Comparative performance tests on the Mod-2, 2.5-mW wind turbine with and without vortex generators
p 377 N95-27978
- Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system
p 440 N95-27983

VORTEX RINGS

- Active open-loop control of particle dispersion in round jets
[HTN-95-42334] p 372 A95-86163

VORTEX SHEDDING

- Flow past a symmetric wedge with forward splitter plate
p 427 A95-82406
- Sphere wakes at moderate Reynolds numbers in a turbulent environment
[HTN-95-42331] p 372 A95-86160

VORTICES

- Measurements of vortex pair interaction with a clean or contaminated free surface
[BTN-94-EIX95011441063] p 429 A95-82798
- Vortex methods for the computational analysis of rotor/body interaction
[HTN-95-61072] p 369 A95-83656
- Structure of supersonic jet flow and its radiated sound
[HTN-95-51645] p 431 A95-85027
- Crossflow topology of vortical flows
[HTN-95-51664] p 432 A95-85046
- Force and moment on a Joukowski profile in the presence of point vortices
[BTN-95-EIX95262694298] p 434 A95-85469
- Compressible inviscid vortex flow of a sharp edge delta wing
[BTN-95-EIX95262694308] p 370 A95-85479
- Mixing enhancement by and noise characteristics of streamwise vortices in an air jet
[HTN-95-42322] p 371 A95-86151
- Quantitative investigation of compressible mixing: Staged transverse injection into Mach 2 flow
[HTN-95-42330] p 404 A95-86159
- Near field of a coaxial jet with and without axial excitation
[HTN-95-42332] p 372 A95-86161
- Interferometric investigations of compressible dynamic stall over a transiently pitching airfoil
[HTN-95-42338] p 372 A95-86167
- Airborne measurements during the European Arctic Stratospheric Ozone Experiment: Observation of OCIO
[HTN-95-00745] p 445 A95-86315
- Flutter clearance flight tests of an OV-10A airplane modified for wake vortex flight experiments
[NASA-TM-109168] p 366 N95-26381
- Suppressor of oscillations in airframe cavities
[AD-D017265] p 388 N95-26507
- Numerical simulation of the flow about the F-18 HARV at high angle of attack
[NASA-CR-197755] p 374 N95-26735
- Effects of three-dimensional imposed 3-D disturbances on bluff-body near wake flows
[AD-A289553] p 374 N95-26757
- Performance characterization of a highly-offset diffuser with and without blowing vortex generator jets
[AD-A289334] p 375 N95-26901

- The near-wake flow behavior of an oscillating airfoil with modified trailing edge
p 375 N95-26953
- A general theory of two- and three-dimensional rotational flow in subsonic and transonic turbomachines
[NASA-CR-4496] p 377 N95-28003

VORTICITY

- Measurements of vortex pair interaction with a clean or contaminated free surface
[BTN-94-EIX95011441063] p 429 A95-82798
- Vortex methods for the computational analysis of rotor/body interaction
[HTN-95-61072] p 369 A95-83656
- Two-dimensional viscous flow past a flat plate
[HTN-95-42210] p 430 A95-84026
- Development of a large-aspect-ratio rectangular turbulent free jet
[HTN-95-42333] p 372 A95-86162
- Two dimensional stratospheric aerosol distributions during EASOE
[HTN-95-00726] p 444 A95-86296
- Basic studies in turbulent shear flows
[AD-A289145] p 437 N95-26998
- Calculation of three-dimensional (3-D) internal flow by means of the velocity-vorticity formulation on a staggered grid
[NASA-TM-110352] p 376 N95-27258

W**WAKES**

- Numerical investigation of cylinder wake flow with a rear stagnation jet
[HTN-95-51669] p 433 A95-85051
- Prediction of two-dimensional momentumless wake by k-epsilon-gamma model
[BTN-95-EIX95262694299] p 434 A95-85470
- Flutter clearance flight tests of an OV-10A airplane modified for wake vortex flight experiments
[NASA-TM-109168] p 366 N95-26381
- Rarefied gas effects on aerobraking/reentry vehicles with wakes
[NASA-CR-196586] p 415 N95-27093
- WALL FLOW**
- Multiple instabilities of three-dimensional boundary layers along a concave wall
[HTN-95-71126] p 429 A95-83487
- The effects of wall perturbations on thermo-turbulent Couette flow
[HTN-95-82255] p 434 A95-85299
- WALL PRESSURE**
- Evaluation of scramjet nozzle performance
p 402 A95-82321

WALL TEMPERATURE

- Viscous shock-layer analysis on hypersonic flow over reentry capsule with nonequilibrium chemistry
[ISAS-656] p 436 N95-26739

WAR GAMES

- Integrated mission precision attack cockpit technology (IMPACT). Phase 1: Identifying technologies for air-to-ground fighter integration
[AD-A289562] p 389 N95-26684
- A mathematical analysis of the Janus combat simulation weather effects models and sensitivity analysis of sky-to-ground brightness ratio on target detection
[AD-A289629] p 446 N95-26858
- WARNING SYSTEMS**
- Part-task simulator evaluations of advanced terrain displays
[SAE PAPER 932570] p 401 A95-84567
- Control system design for the MOD-5A 7.3 mW wind turbine generator
p 440 N95-27985

WATER TUNNEL TESTS

- NASA Dryden flow visualization facility
[NASA-TM-4631] p 449 N95-27914

WATER VEHICLES

- Air cushioned landing craft (LCAC) based ship to shore movement simulation: A decision aid for the amphibious commander. A (SMMAT) application
[AD-A289635] p 436 N95-26722

WATER WAVES

- Fractal properties of whitecaps
[HTN-95-92121] p 443 A95-83827

WAVE DRAG

- Computational fluid dynamics and transonic flow
[AD-A288962] p 436 N95-26405

WAVEFORMS

- Speech analysis and synthesis based on pitch-synchronous segmentation of the speech waveform
[AD-A288824] p 435 N95-26349

WEAPONS DEVELOPMENT

- Report to Congressional Committees. Comanche Helicopter: Testing needs to be completed prior to production decisions
[GAO/NSIAD-95-112] p 397 N95-27910

WEATHER

- WINCLR: A computer code for heat transfer and clearance calculation in a compressor
[NASA-CR-195436] p 366 N95-26363
- A mathematical analysis of the Janus combat simulation weather effects models and sensitivity analysis of sky-to-ground brightness ratio on target detection
[AD-A289629] p 446 N95-26858

WEATHERING

- The use of electrochemistry and ellipsometry for identifying and evaluating corrosion on aircraft
[AD-A288536] p 381 N95-27186

WEATHERPROOFING

- Mobile domes for TACTIC telescope
p 453 A95-86113

WEAVING

- Characterization and manufacture of braided composites for large commercial aircraft structures
p 426 N95-28478

WEDGE FLOW

- Flow past a symmetric wedge with forward splitter plate
p 427 A95-82406

WEDGES

- Flow past a symmetric wedge with forward splitter plate
p 427 A95-82406

WEIBULL DENSITY FUNCTIONS

- Proof test methodology for composites
p 424 N95-28445

WEIGHT ANALYSIS

- The analysis of the processing increased weight for pilot production of F-X aircraft
[HTN-95-71133] p 385 A95-83494

WEIGHTING FUNCTIONS

- F/A-18 IFOSTP Fatigue test airbag load determination on the vertical and horizontal tails
[DSTO-TR-0135] p 388 N95-26389

WEIGHTLESSNESS

- Experimental investigation of composite channel heat pipe operation in micro-gravity environment
p 428 A95-82645

WELDING

- Forming and bonding techniques for high-strength aluminum alloys
[HTN-95-20605] p 418 A95-84786

WIND TUNNEL MODELS

- Experimental investigation of static and dynamic ground effect on HOPE ALFLEX vehicle
[NAL-TR-1236] p 388 N95-26525

WIND TUNNEL TESTS

- Design features of the NAL ramjet engine test facility
p 410 A95-82319
- Hypersonic wind tunnel test of sidewall compression type scramjet inlet
p 410 A95-82320
- An experimental investigation of scramjet nozzle flow
p 402 A95-82322
- Computational/experimental investigation of staged injection into a Mach 2 flow
[HTN-95-51646] p 432 A95-85028
- Surface interference in Rayleigh scattering measurements near forebodies
[HTN-95-51670] p 433 A95-85052
- Wind-tunnel tests of an inclined cylinder having helical grooves
[BTN-95-EIX95262694306] p 411 A95-85477
- Airfoil modification effects on subsonic and transonic pressure distributions and performance for the EA-6B airplane
[NASA-TP-3516] p 373 N95-26382
- Experimental investigation of static and dynamic ground effect on HOPE ALFLEX vehicle
[NAL-TR-1236] p 388 N95-26525
- Wind tunnel experiments on wake flow field behind a reentry capsule from a viewpoint of parachute deployment at supersonic speeds
[ISAS-655] p 374 N95-26740
- Effects of three-dimensional imposed 3-D disturbances on bluff-body near wake flows
[AD-A289553] p 374 N95-26757
- An experimental investigation of helicopter downwash and tailboom interaction at the Wichita State University 7x10 foot wind tunnel
p 375 N95-26955
- Incorporating biplane wing theory into a large, subsonic, all-cargo transport
p 391 N95-26956
- The lift-fan aircraft: Lessons learned
[NASA-CR-196694] p 392 N95-27143
- Sailplane glide performance and control using fixed and articulating winglets
[NASA-CR-198579] p 392 N95-27180
- Wind-tunnel test of the S814 thick root airfoil
[DE95-000268] p 376 N95-27541
- Further investigations of icing effects on an advanced high-lift multi-element airfoil
[NASA-TM-106947] p 381 N95-27762

Modeling of aircraft unsteady aerodynamic characteristics. Part 2: Parameters estimated from wind tunnel data p 410 N95-27839
 [NASA-TM-110161]
 Collected papers on wind turbine technology p 447 N95-27970
 [NASA-CR-195432]
 Horizontal axis wind turbine post stall airfoil characteristics synthesis p 376 N95-27974
 Comparative wind tunnel tests of NACA 23024 airfoils with several aileron and spoiler configurations p 376 N95-27976
 Comparative wind tunnel test at high Reynolds numbers of NACA 64 621 airfoils with two aileron configurations p 377 N95-27977
 Flow structure generated by perpendicular blade vortex interaction and implications for helicopter noise predictions p 377 N95-28193
 [NASA-CR-198590]
 Performance study for inlet installations p 406 N95-28227
 [NASA-CR-189714]
 Measurements of store forces and moments and cavity pressures for a generic store in and near a box cavity at subsonic and transonic speeds p 378 N95-28241
 [NASA-TM-4611]
 Construction and wind tunnel test of a 1/12th scale helicopter model p 378 N95-28331
 [AD-A288487]
 Experimental investigation of inlet-combustor isolators for a dual-mode scramjet at a Mach number of 4 p 407 N95-28343
 [NASA-TP-3502]
 Study of potential aerodynamic benefits from spanwise blowing at wingtip p 378 N95-28669
 [NASA-TP-3515]
 Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils p 378 N95-28674
 [NASA-TP-3496]
WIND TUNNELS
 Rarefied gas numerical wind tunnel: OREX and HOPE p 427 A95-82391
 Anechoic wind tunnel study of turbulence effects on wind turbine broadband noise p 451 N95-27992
WIND TURBINES
 A comparison of measured wind park load histories with the WISPER and WISPERX load spectra p 446 N95-27459
 [DE95-000295]
 Collected papers on wind turbine technology p 447 N95-27970
 [NASA-CR-195432]
 Horizontal axis wind turbine post stall airfoil characteristics synthesis p 376 N95-27974
 Preliminary analysis of dynamic stall effects on a 91-meter wind turbine rotor p 376 N95-27975
 Comparative wind tunnel test at high Reynolds numbers of NACA 64 621 airfoils with two aileron configurations p 377 N95-27977
 Comparative performance tests on the Mod-2, 2.5-mW wind turbine with and without vortex generators p 377 N95-27978
 Design of a real-time wind turbine simulator using a custom parallel architecture p 449 N95-27979
 A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines p 439 N95-27980
 Aeroelastic stability of wind turbine blade/aileron systems p 377 N95-27981
 Calculation of design load for the MOD-5A 7.3 mW wind turbine system p 440 N95-27982
 Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system p 440 N95-27983
 Control system design for the MOD-5A 7.3 mW wind turbine generator p 440 N95-27985
 Use of blade pitch control to provide power train damping for the Mod-2, 2.5-mW wind turbine p 440 N95-27986
 Variable speed generator application on the MOD-5A 7.3 mW wind turbine generator p 440 N95-27989
 Measurement and prediction of broadband noise from large horizontal axis wind turbine generators p 451 N95-27990
 Observed acoustic and aeroelastic spectral responses of a MOD-2 turbine blade to turbulence excitation p 451 N95-27991
 Anechoic wind tunnel study of turbulence effects on wind turbine broadband noise p 451 N95-27992
WIND VELOCITY
 Preliminary analysis of dynamic stall effects on a 91-meter wind turbine rotor p 376 N95-27975
 Comparative wind tunnel tests of NACA 23024 airfoils with several aileron and spoiler configurations p 376 N95-27976
 Comparative wind tunnel test at high Reynolds numbers of NACA 64 621 airfoils with two aileron configurations p 377 N95-27977
 Comparative performance tests on the Mod-2, 2.5-mW wind turbine with and without vortex generators p 377 N95-27978

Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system p 440 N95-27983
 The performance of cargo airdrop systems using g-12E parachutes: Statistical determination of minimum altitude [AD-A291666] p 381 N95-28454
WIND VELOCITY MEASUREMENT
 Comparative performance tests on the Mod-2, 2.5-mW wind turbine with and without vortex generators p 377 N95-27978
WINDOWS (APERTURES)
 Development of repair processes and sources for C/KC-135 aircraft windows/windshields [AD-A288348] p 367 N95-26629
WINDPOWER UTILIZATION
 Collected papers on wind turbine technology [NASA-CR-195432] p 447 N95-27970
 Comparative performance tests on the Mod-2, 2.5-mW wind turbine with and without vortex generators p 377 N95-27978
 Design of a real-time wind turbine simulator using a custom parallel architecture p 449 N95-27979
WINDPOWERED GENERATORS
 Collected papers on wind turbine technology [NASA-CR-195432] p 447 N95-27970
 Control system design for the MOD-5A 7.3 mW wind turbine generator p 440 N95-27985
 Variable speed generator application on the MOD-5A 7.3 mW wind turbine generator p 440 N95-27989
 Measurement and prediction of broadband noise from large horizontal axis wind turbine generators p 451 N95-27990
WINDSHIELDS
 Development of repair processes and sources for C/KC-135 aircraft windows/windshields [AD-A288348] p 367 N95-26629
WING CAMBER
 Unique considerations in the design and experimental evaluation of tailored wings with elastically produced chordwise camber p 423 N95-28436
WING OSCILLATIONS
 Transonic flutter suppression using active acoustic excitations [BTN-95-ElX95262694310] p 408 A95-85481
WING PANELS
 Structural modification and repair of C-130 wing structure using bonded composites p 394 N95-27512
 Composite or metallic bolted repairs on self-stiffened carbon wing panel of the commuter ATR72 design criteria, analysis, verification by test p 396 N95-27525
WING-FUSELAGE STORES
 Airfoil modification effects on subsonic and transonic pressure distributions and performance for the EA-6B airplane [NASA-TP-3516] p 373 N95-26382
WINGLETS
 Sailplane glide performance and control using fixed and articulating winglets [NASA-CR-198579] p 392 N95-27180
WINGS
 A concept of a hypersonic flight experiment of a winged vehicle p 414 A95-82477
 Atmospheric reentry flight test of winged space vehicle p 414 A95-82483
 An inverse design method of transonic airfoil and wing [HTN-95-71128] p 385 A95-83489
 Analysis of backscattering from wing and fuselage joints [HTN-95-71134] p 430 A95-83495
 Active plate and missile wing development using directionally attached piezoelectric elements [HTN-95-42340] p 408 A95-86169
 Demonstration study of hierarchical control of fluid-dynamic phenomena [AD-A289341] p 437 N95-26751
 A numerical method for unsteady transonic flow about wings with control surfaces [AD-A289631] p 375 N95-26859
 Advanced formation flight control [AD-A289271] p 409 N95-26981
 Design and structural validation of CF116 upper wing skin boron doubler p 393 N95-27510
 Vibrational behavior of adaptive aircraft wing structures modelled as composite thin-walled beams p 423 N95-28435
 Unique considerations in the design and experimental evaluation of tailored wings with elastically produced chordwise camber p 423 N95-28436
 C-130 Advanced Technology Center wing box conceptual design/cost study p 423 N95-28437
 Structural testing of the technology integration box beam p 441 N95-28467
 Test and analysis results for composite transport fuselage and wing structures p 398 N95-28470

Application of damage tolerance methodology in certification of the Piaggio P-180 Avanti p 399 N95-28480
 Advanced wing design survivability testing and results p 400 N95-28488

WINTER

An overview of the EASOE campaign [HTN-95-00702] p 443 A95-86272
 Aircraft measurements of CLO and HCL during EASOE 1991/92 p 444 A95-86291
 [HTN-95-00721]
 An overview of millimeter-wave spectroscopic measurements of chlorine monoxide at Thule, Greenland, February-March, 1992: Vertical profiles, diurnal variation, and longer-term trends p 444 A95-86292
 [HTN-95-00722]
 Two dimensional stratospheric aerosol distributions during EASOE p 444 A95-86296
 [HTN-95-00726]
 Airborne measurements during the European Arctic Stratospheric Ozone Experiment column amounts of HNO₃ and O₃ derived from FTIR emission sounding [HTN-95-00742] p 445 A95-86312
 Airborne measurements during the European Arctic Stratospheric Ozone Experiment: Observation of OClO [HTN-95-00745] p 445 A95-86315
 Airborne measurements during the Arctic stratospheric experiment: Observation of O₃ and NO₂ [HTN-95-00748] p 445 A95-86318

WIRING

Partial discharge testing of high voltage wiring harness for airborne displays [AD-A289150] p 401 N95-27003
 AH-1F COBRA rewire program MANPRINT analysis [AD-A289190] p 391 N95-27018

WORKLOADS (PSYCHOPHYSIOLOGY)

Integrated mission precision attack cockpit technology (IMPACT). Phase 1: Identifying technologies for air-to-ground fighter integration [AD-A289562] p 389 N95-26684
 Full span flaperons for a biplane p 391 N95-26954

WORKSTATIONS

A study of workstation computational performance for real-time flight simulation [NASA-TM-109184] p 449 N95-27241

WOVEN COMPOSITES

Development of stitched/RTM composite primary structures p 425 N95-28469

Y**YAWING MOMENTS**

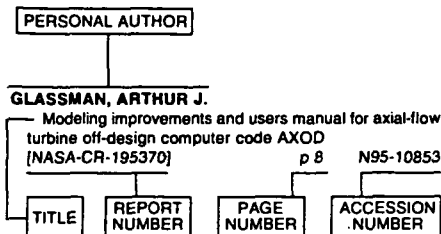
Sailplane glide performance and control using fixed and articulating winglets [NASA-CR-198579] p 392 N95-27180

PERSONAL AUTHOR INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 321)

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Typical Personal Author Index Listing



Listings in this index are arranged alphabetically by personal author. The title of the document is used to provide a brief description of the subject matter. The report number helps to indicate the type of document (e.g., NASA report, translation, NASA contractor report). The page and accession numbers are located beneath and to the right of the title. Under any one author's name the accession numbers are arranged in sequence.

A

- AARONSON, PHILIP G.**
Supersonic transport grid generation, validation, and optimization
[NASA-CR-197752] p 448 N95-26648
- ABBUD-MADRID, A.**
Stationary premixed flames in spherical and cylindrical geometries
[HTN-95-42336] p 418 A95-86165
- ABE, TAKASHI**
Reentry technology experiment on the first mission of reentry capsule 'EXPRESS' p 414 A95-82499
How 'HITEN's' aerobraking experiments were carried out p 415 A95-82553
Aero-thermodynamic flight environment at HITEN aerobrake experiment p 415 A95-82554
Viscous shock-layer analysis on hypersonic flow over reentry capsule with nonequilibrium chemistry [ISAS-656] p 436 N95-26739
Wind tunnel experiments on wake flow field behind a reentry capsule from a viewpoint of parachute deployment at supersonic speeds [ISAS-655] p 374 N95-26740
- ABUMERI, G. H.**
Analysis of aircraft engine blade subject to ice impact p 407 N95-28277
- ACEVES, S. M.**
A hybrid vehicle evaluation code and its application to vehicle design. Revision 1 [DE95-008053] p 441 N95-28029
A hybrid vehicle evaluation code and its application to vehicle design, revision 2 [DE95-008060] p 441 N95-28139
- AHMED, S.**
Reattachment studies of an oscillating airfoil dynamic stall flowfield [HTN-95-51660] p 432 A95-85042
- AHN, JONG WOO**
Prediction of two-dimensional momentumless wake by k-epsilon-gamma model [BTN-95-EIX95262694299] p 434 A95-85470
- AHUJA, K. K.**
Screech tones from free and ducted supersonic jets [HTN-95-51647] p 432 A95-85029

- AKIBA, RYOJIRO**
Atmospheric reentry flight test of winged space vehicle p 414 A95-82483
Development and flight results of fiber reinforced balloon p 384 A95-82511
- AKIMOTO, TOSHIO**
NAL aerothermodynamic probing and CFD verification mission in OREX experiment p 368 A95-82413
- AKIYAMA, M.**
Polar Patrol Balloon system and preliminary experimental results p 368 A95-82513
- ALIAGA, D. A.**
Convection heat transfer distributions over plates with square ribs from infrared thermography measurements [HTN-95-20713] p 435 A95-86603
- ALLISON, DENNIS O.**
Airfoil modification effects on subsonic and transonic pressure distributions and performance for the EA-6B airplane [NASA-TP-3516] p 373 N95-26382
- AMAGASA, S.**
Study on the turbine vane and blade for a 1500 C class industrial gas turbine [BTN-94-EIX95011441254] p 431 A95-84211
- AMBUR, DAMODAR R.**
Technology integration box beam failure study p 441 N95-28468
Damage tolerance of a geodesically stiffened advanced composite structural concept for aircraft structural applications p 399 N95-28487
- AMRANE, K.**
Second-law analysis of vapor compression heat pumps with solution circuit [BTN-94-EIX95011441236] p 431 A95-84193
- ANASTASSIU, HRISTOS T.**
Hybrid finite element-modal analysis of jet engine inlet scattering [BTN-95-EIX95242673665] p 427 A95-82259
- ANDERSEN, T. T.**
Pressure and temperature distortion testing of a two-stage centrifugal compressor [BTN-94-EIX95011441250] p 431 A95-84207
- ANDERSON, ROBERT L.**
Advanced tow placement of composite fuselage structure p 420 N95-28271
- ANDERSON, W. KYLE**
Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils [NASA-TP-3496] p 378 N95-28674
- ANDERTON, JAMES F.**
Stall precursor study of high frequency data for three high speed, swept compressor rotors [AD-A289379] p 406 N95-26878
- ANDREWS, R. G.**
The effects of surface modification on fretting fatigue in Ti alloy turbine components [HTN-95-61145] p 404 A95-84909
- ANEMAAT, WILLIAM**
An easy way to analyze longitudinal and lateral-directional trim problems with AEO or OEI p 409 N95-26949
- ANTAR, B. N.**
Study of heat transfer rates during quenching of a hot tube under microgravity p 428 A95-82641
- AOKI, S.**
Study on the turbine vane and blade for a 1500 C class industrial gas turbine [BTN-94-EIX95011441254] p 431 A95-84211
- AOYAMA, K.**
Study on the turbine vane and blade for a 1500 C class industrial gas turbine [BTN-94-EIX95011441254] p 431 A95-84211
- ARAI, K.**
Development of 70MW class superconducting generators [BTN-94-EIX95011440854] p 429 A95-82905
- ARAI, TATSUO**
Design features of the NAL ramjet engine test facility p 410 A95-82319
- ARDEMA, MARK D.**
Optimal trajectories for hypersonic launch vehicles [HTN-95-61120] p 415 A95-84884
- ARNOLD, F.**
An overview of the EASOE campaign [HTN-95-00702] p 443 A95-86272
- ARONE, R.**
Prediction of fatigue crack growth under constant amplitude and random loading using specimens with multiple cracks [AD-A291614] p 397 N95-28409
- ASO, SHIGERU**
Numerical simulation of unsteady aerodynamic heating induced by shock reflections p 428 A95-82418
A study on aerodynamic heating phenomena in three-dimensional shock wave/turbulent boundary layer interaction induced by sweptback sharp fins at supersonic flow p 428 A95-82419
- ASWATHA NARAYANA, P. A.**
Boundary layer studies over an S-blade [HTN-95-92261] p 434 A95-85305
- ATHAVALLE, M. M.**
Numerical analysis of intra-cavity and power-stream flow interaction in multiple gas-turbine disk-cavities [NASA-TM-106886] p 407 N95-28344
- ATHAVALLE, MAHESH**
Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics [NASA-TM-106685] p 416 N95-27434
- ATKINS, H.**
Nonreflective boundary conditions for high-order methods [HTN-95-42328] p 371 A95-86157
- ATLURI, S. N.**
A FEAM based methodology for analyzing composite patch repairs of metallic structures p 394 N95-27511
- ATTIA, M.**
GETRAN: A generic, modularly structured computer code for simulation of dynamic behavior of aero- and power generation gas turbine engines [BTN-94-EIX95011441241] p 431 A95-84198
- AUBIN, BRUCE**
Maintenance programs [HTN-95-92310] p 365 A95-85354
- AUSLENDER, AARON H.**
Experimental investigation of inlet-combustor isolators for a dual-mode scramjet at a Mach number of 4 [NASA-TP-3502] p 407 N95-28343
- AVERY, W. B.**
Tension fracture of laminates for transport fuselage. Part 1: Material screening p 398 N95-28471
Impact damage resistance of composite fuselage structure, part 1 p 399 N95-28482

B

- BAART, DOUGLAS**
The 1994 updated National Aerospace System performance assessment for year 2005 [AD-A288652] p 380 N95-26485
- BABBITT, B. A.**
Assessment of cost and training effectiveness for a candidate training system using the Comparison-Based Prediction model [SAE PAPER 932598] p 379 A95-84570
- BAGINSKI, FRANK**
Variational principles for ascent shapes of large scientific balloons [BTN-95-EIX95262694320] p 387 A95-85491
- BAHETI, S. K.**
Thermo-hydrodynamic solution of floating ring seals for high pressure compressors using the finite-element method [HTN-95-92246] p 433 A95-85290
- BAILEY, JIM**
The controller memory guide. Concepts from the field [AD-A289263] p 383 N95-26978
- BAILLY, CHRISTOPHE**
Stochastic approach to noise modeling for free turbulent flows [HTN-95-42321] p 371 A95-86150

BAKER, A. A.

- Bonded composite repair of metallic aircraft components: Overview of Australian activities p 392 N95-27505
- Bonded composite repair of thin metallic materials: Variable load amplitude and temperature cycling effects p 393 N95-27509
- Scarf repairs to graphite/epoxy components p 396 N95-27523

BAKER, A. J.

- Accuracy and efficiency assessments for a weak statement CFD algorithm for high-speed aerodynamics [BTN-94-EIX95011441238] p 370 A95-84195

BAKER, A. M.

- A fixed time performance evaluation of parallel CFD applications [DE94-014240] p 436 N95-26445

BALABASKARAN, V.

- Boundary layer studies over an S-blade [HTN-95-92261] p 434 A95-85305

BALL, A. S.

- Adhesively bonded composite patch repair of cracked aluminum alloy structures p 393 N95-27507

BANDA, SIVA S.

- Robust longitudinal axis flight control for an aircraft with thrust vectoring [BTN-95-EIX95122538875] p 408 A95-83000

BANOWETZ, VIRGIL

- An evaluation of the Software Through Pictures/T Tool (SiP/T) for the Software Support Activity (SSA) [AD-A288822] p 447 N95-26348

BARBATO, GREGORY J.

- Integrated mission precision attack cockpit technology (IMPACT). Phase 1: Identifying technologies for air-to-ground fighter integration [AD-A289562] p 389 N95-26684

BARRETT, RON

- Active plate and missile wing development using directionally attached piezoelectric elements [HTN-95-42340] p 408 A95-86169

BARRIE, RONALD E.

- Advanced textile applications for primary aircraft structures p 399 N95-28476

BARRIACARDABA, A.

- Repairs of CFC primary structures p 396 N95-27527

BARTON, ROBERT S.

- Control system design for the MOD-5A 7.3 mW wind turbine generator p 440 N95-27985
- Variable speed generator application on the MOD-5A 7.3 mW wind turbine generator p 440 N95-27989

BASIL, VICTOR

- Software process improvement in the NASA software engineering laboratory [AD-A289912] p 450 N95-28627

BAST, CALLIE C.

- Probabilistic material strength degradation model for Inconel 718 components subjected to high temperature, high-cycle and low-cycle mechanical fatigue, creep and thermal fatigue effects [NASA-CR-197832] p 419 N95-27167

BAUER, F.

- Acoustic field in unsteady moving media [NASA-CR-198162] p 438 N95-27179

BAUER, J.

- On aircraft repair verification of a fighter A/C integrally stiffened fuselage skin p 394 N95-27515

BAYLISS, A.

- Interaction of jet noise with a nearby panel assembly [BTN-95-EIX95262694295] p 434 A95-85466
- Response of multi-panel assembly to noise from a jet in forward motion [NASA-CR-198164] p 442 N95-28673

BAYSAL, OKTAY

- Dynamic unstructured method for flows past multiple objects in relative motion [BTN-95-EIX95262694303] p 435 A95-85474

BEARMAN, PETER W.

- Effects of three-dimensional imposed 3-D disturbances on bluff-body near wake flows [AD-A289553] p 374 N95-26757

BECHARA, WALID

- Stochastic approach to noise modeling for free turbulent flows [HTN-95-42321] p 371 A95-86150

BELASON, E. B.

- Status of bonded boron/epoxy doublers for military and commercial aircraft structures p 393 N95-27506

BELL, DAVID K.

- Proof test methodology for composites p 424 N95-28445

BENAK, T. J.

- Bonded composite repair of thin metallic materials: Variable load amplitude and temperature cycling effects p 393 N95-27509

BENNER, WILLIAM

- Weather And Radar Processor (WARP) Test and Evaluation Master Plan (TEMP) [AD-A288280] p 445 N95-26453

BERGAMINI, LORENZO

- Using the Liou-Steffen algorithm for the Euler and Navier-Stokes equations [HTN-95-42348] p 373 A95-86177

BERGSTROM, SHERRY

- Maintenance programs [HTN-95-92310] p 365 A95-85354

BERRY, LEE A.

- Permanent magnet electron cyclotron resonance plasma source with remote window [BTN-95-EIX95242674338] p 450 A95-82176

BETTNER, JAMES L.

- Propulsion system assessment for very high UAV under ERAST [NASA-CR-195469] p 406 N95-27866

BHAT, C. L.

- Mobile domes for TACTIC telescope p 453 A95-86113

BIANCO, JEAN

- NASA Lewis Research Center's combustor test facilities and capabilities [NASA-TM-106903] p 412 N95-27176

BIETERMAN, M. B.

- TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual [NASA-CR-4349] p 377 N95-28230

- TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document [NASA-CR-4348] p 378 N95-28265

BIGGERS, SHERRILL B.

- Shear buckling response of tailored composite plates [HTN-95-51680] p 418 A95-85062

BINGAMAN, DONALD C.

- Performance study for inlet installations [NASA-CR-189714] p 406 N95-28227

BIRCH, STUART

- Aircraft stripping and painting [HTN-95-92311] p 365 A95-85355

BITZER, MICHAEL

- Reentry technology experiment on the first mission of reentry capsule 'EXPRESS' p 414 A95-82499

BLACKWELL, JEREMY

- Tie-down trials involving a Sikorsky S-70B-2 helicopter [DSTO-TR-0132] p 400 N95-28567

BLANDFORD, CRAIG S.

- Propulsion system assessment for very high UAV under ERAST [NASA-CR-195469] p 406 N95-27866

BLANKEN, C. L.

- An investigation of the effects of pitch-roll (de)coupling on helicopter handling qualities [NASA-TM-110349] p 409 N95-26773

BLISS, D. B.

- Vortex methods for the computational analysis of rotor/body interaction [HTN-95-61072] p 369 A95-83656

BUSSELL, W. A., JR.

- Use of blade pitch control to provide power train damping for the Mod-2, 2.5-mW wind turbine p 440 N95-27986

BLOM, C. E.

- Airborne measurements during the European Arctic Stratospheric Ozone Experiment column amounts of HNO₃ and O₃ derived from FTIR emission sounding [HTN-95-00742] p 445 A95-86312

BOBISH, KIMBERLY

- CAE for thermal management of aerospace electronic boards using the BETASoft program p 438 N95-27354

BOBULA, G. A.

- Pressure and temperature distortion testing of a two-stage centrifugal compressor [BTN-94-EIX95011441250] p 431 A95-84207

BOHON, HERMAN L.

- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 3 [NASA-CR-198718] p 420 N95-28266

- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 1 [NASA-CR-198723] p 421 N95-28420

- Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 2 [NASA-CR-198722] p 424 N95-28462

BOLTRALIK, WILLIAM J.

- AH-1F COBRA rewire program MANPRINT analysis [AD-A289190] p 391 N95-27018

BOMAR, JOHN B., JR.

- The large radius track centrifuge concept as an acceleration research and simulation device p 379 A95-84560

BONHAUS, DARYL L.

- Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils [NASA-TP-3496] p 378 N95-28674

BOOTH, EARL R., JR.

- A higher harmonic control test in the DNW to reduce impulsive BVI noise [HTN-95-61071] p 385 A95-83655

BORCHERS, PAUL F.

- Simulation model of the integrated flight/propulsion control system, displays, and propulsion system for ASTOVL lift-fan aircraft [NASA-TM-108866] p 405 N95-26412

BOSE, NEIL

- Explicit Kutta condition for an unsteady two-dimensional constant potential panel method [HTN-95-51679] p 433 A95-85061

BOSE, T. K.

- WINCLR: A computer code for heat transfer and clearance calculation in a compressor [NASA-CR-195436] p 366 N95-26363

BOTHWELL, CHRISTOPHER M.

- Torsional actuation with extension-torsion composite coupling and a magnetostrictive actuator [BTN-95-EIX95262694314] p 435 A95-85485

BOTT, RICHARD

- Composite flight-control actuator development p 410 N95-28281

BOUSLEG, STANLEY A.

- Reentry analysis for low Earth orbiting spacecraft p 415 A95-85774

BOWLES, JEFFREY V.

- Optimal trajectories for hypersonic launch vehicles [HTN-95-61120] p 415 A95-84884

BOYCE, LOLA

- Probabilistic material strength degradation model for Inconel 718 components subjected to high temperature, high-cycle and low-cycle mechanical fatigue, creep and thermal fatigue effects [NASA-CR-197832] p 419 N95-27167

BRAATEN, M.

- Combustion system CFD modeling at GE Aircraft Engines p 439 N95-27889

BRAATHEN, G.

- An overview of the EASOE campaign [HTN-95-00702] p 443 A95-86272

BRAININ, L.

- Stress considerations in reduced-size aeroelastic optimization [BTN-95-EIX95262694313] p 366 A95-85484

BRANDTJEN, RONALD

- Airborne measurements during the European Arctic Stratospheric Ozone Experiment: Observation of OCIO [HTN-95-00745] p 445 A95-86315

BREININGER, DAVID R.

- A review of falconry as a bird control technique with recommendations for use at the Shuttle Landing Facility, John F. Kennedy Space Center, Florida, USA [NASA-TM-110142] p 381 N95-27859

BRITCHER, COLIN P.

- Extension to the dynamic modeling of the large angle magnetic suspension test fixture [NASA-CR-197801] p 411 N95-26768

BRITTON, T. W.

- Development of a coding form for approach control/pilot voice communications [DOT/FAA/AM-95/15] p 384 N95-28540

BROCKMEYER, J. W.

- Ceramic composite attachments for transmission of high-torque loads [BTN-94-EIX95011441256] p 417 A95-84213

BROOKS, THOMAS F.

- A higher harmonic control test in the DNW to reduce impulsive BVI noise [HTN-95-61071] p 385 A95-83655

BROWN, RICHARD T.

- Through-the Thickness(R) braided composites for aircraft applications p 421 N95-28273

BROWN, T.

- Composite fuselage crown panel manufacturing technology p 399 N95-28474

BRUNO, J.

- Advanced wing design survivability testing and results p 400 N95-28488

BRUZZINI, MICHAEL A.

- Development of a TECS control-law for the lateral directional axis of the McDonnell Douglas F-15 Eagle [AD-A289771] p 410 N95-28598

BUFFINGTON, JAMES M.

- Robust longitudinal axis flight control for an aircraft with thrust vectoring [BTN-95-EIX95122538875] p 408 A95-83000

BURLEY, CASEY L.

Aircraft noise prediction program theoretical manual: Rotorcraft System Noise Prediction System (ROTONET), part 4
[NASA-TM-83199-PT-4] p 451 N95-26392

BURPO, S. J.

ACT/ICAPS: Thermoplastic composite activities p 421 N95-28274

BURRUS, D.

Combustion system CFD modeling at GE Aircraft Engines p 439 N95-27889

BURTON, RALPH A.

The effects of wall perturbations on thermo-turbulent Couette flow
[HTN-95-92255] p 434 A95-85299

BUSKA, STEVEN

Micro-time stress measurement device development
[AD-A289511] p 448 N95-26845

BUSSOLETTI, J. E.

TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual
[NASA-CR-4349] p 377 N95-28230
TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document
[NASA-CR-4348] p 378 N95-28265

BYUN, CHANSUP

Aeroelasticity of wing and wing-body configurations on parallel computers
[NASA-CR-197756] p 389 N95-26590

C**CABELL, R. H.**

Artificial neural networks for predicting nonlinear dynamic helicopter loads
[HTN-95-51678] p 404 A95-85060

CALDWELL, JOHN A., JR.

The effects of UH-1 experience on UH-60 simulator performance: A preliminary study
[AD-A289457] p 391 N95-26993

CANDEL, SEBASTIEN M.

Stochastic approach to noise modeling for free turbulent flows
[HTN-95-42321] p 371 A95-86150

CAPASSO, MICHAEL A.

Construction and wind tunnel test of a 1/12th scale helicopter model
[AD-A288487] p 378 N95-28331

CARDEN, HUEY D.

Effects of floor location on response of composite fuselage frames p 423 N95-28439

CARR, L. W.

Interferometric investigations of compressible dynamic stall over a transiently pitching airfoil
[HTN-95-42338] p 372 A95-86167

CARTER, DOUGLAS W.

Rapid repair of large area damage to contoured aircraft structures p 394 N95-27516

CASPER, ANN M.

Dynamically timed electric motor
[NASA-CASE-MFS-28958-1] p 437 N95-26890

CASPER, JAY

Nonreflective boundary conditions for high-order methods
[HTN-95-42328] p 371 A95-86157

CAULKINS, RONALD W.

Condition monitoring and diagnostics
[HTN-95-92312] p 387 A95-85356

CEBECI, TUNCER

Predicting stall and post-stall behavior of airfoils at low mach numbers
[BTN-95-EIX95262694297] p 365 A95-85468

CHAIT, RICHARD

Utilization of composite materials by the US Army: A look ahead p 421 N95-28421

CHAKRAVARTY, S.

The effects of surface modification on fretting fatigue in Ti alloy turbine components
[HTN-95-61145] p 404 A95-84909

CHAMIS, C. C.

Analysis of aircraft engine blade subject to ice impact p 407 N95-28277

CHAMIS, CHRISTOS C.

Probabilistic evaluation of fuselage-type composite structures p 398 N95-28444

CHANDRA, RAMESH

Torsional actuation with extension-torsion composite coupling and a magnetostrictive actuator
[BTN-95-EIX95262694314] p 435 A95-85485

CHANDRASEKHARA, M. S.

Reattachment studies of an oscillating airfoil dynamic stall flowfield
[HTN-95-51660] p 432 A95-85042

Interferometric investigations of compressible dynamic stall over a transiently pitching airfoil
[HTN-95-42338] p 372 A95-86167

CHANG, RAY C.

High angle-of-attack airfoil performance improvement by internal acoustic excitation
[HTN-95-42347] p 372 A95-86176

CHANG, STEPHEN

Unique considerations in the design and experimental evaluation of tailored wings with elastically produced chordwise camber p 423 N95-28436

CHANG, XIN-YU

An experimental study on radiation from strong shock layer p 368 A95-82421

CHEN, DEYUAN

Nonlinear observer and its application in flight control p 447 A95-82449

CHEN, K. M.

Time-domain imaging of airborne targets using ultra-wideband or short-pulse radar
[BTN-95-EIX95242673673] p 450 A95-82251

CHEN, VICTOR L.

Test and analysis results for composite transport fuselage and wing structures p 398 N95-28470

CHESTER, R. J.

Scarf repairs to graphite/epoxy components p 396 A95-27523

CHEUNG, ANNY

The 1994 updated National Airspace System performance assessment for year 2005
[AD-A288652] p 380 N95-26485

CHEUNG, SAMSON

Supersonic civil airplane study and design: Performance and sonic boom
[NASA-CR-197745] p 390 N95-26813

CHING, FRED

Composite flight-control actuator development p 410 N95-28281

CHINZEI, NOBUO

Prediction of pre-combustion shock in scramjet combustors: A new method p 402 A95-82323

CHOI, D. H.

Two-dimensional viscous flow past a flat plate
[HTN-95-42210] p 430 A95-84026

CHOPRA, INDERJIT

Air resonance of hingeless rotor helicopters in trimmed forward flight
[HTN-95-61075] p 369 A95-83659

An analytical model for a nonlinear elastomeric lag damper and its effect on aeromechanical stability in hover
[HTN-95-61076] p 369 A95-83660

Torsional actuation with extension-torsion composite coupling and a magnetostrictive actuator
[BTN-95-EIX95262694314] p 435 A95-85485

CHOU, JACK C.

Static and fatigue testing of full-scale fuselage panels fabricated using a Therm-X(R) process p 420 N95-28270

CHUNG, W. Y. WILLIAM

Simulation model of the integrated flight/propulsion control system, displays, and propulsion system for ASTOVL lift-fan aircraft
[NASA-TM-108866] p 405 N95-26412

CINNELLA, PASQUALE

General solution procedure for flows in local chemical equilibrium
[HTN-95-42329] p 404 A95-86158

Using the Liou-Steffen algorithm for the Euler and Navier-Stokes equations p 373 A95-86177

CLARK, JOEL P.

The potential for CMCs to replace superalloys in engine exhaust ducts
[HTN-95-42298] p 418 A95-84992

CLARKE, ROBERT A.

AH-1F COBRA rewire program MANPRINT analysis
[AD-A289190] p 391 N95-27018

CLEVELAND, JEFF L., II

A study of workstation computational performance for real-time flight simulation
[NASA-TM-109184] p 449 N95-27241

CLIFTON, JAMES M.

Wind-tunnel tests of an inclined cylinder having helical grooves
[BTN-95-EIX95262694306] p 411 A95-85477

COCHRAN, R.

Field repair materials for naval aircraft p 394 N95-27514

COCHRAN, R. C.

Navy composite maintenance and repair experience p 424 N95-28446

COLLICOTT, STEVEN H.

Surface interference in Rayleigh scattering measurements near forebodies
[HTN-95-51670] p 433 A95-85052

COLLING, JAMES DAVID

Sailplane glide performance and control using fixed and articulating winglets
[NASA-CR-198579] p 392 N95-27180

COLTMAN, JOSEPH W.

Rotorcraft crashworthy airframe and fuel system technology development program
[AD-A289986] p 382 N95-28630

CONNOLLY, JEROME J.

Repair of high temperature composite aircraft structure p 395 N95-27520

CONSIDINE, DAVID B.

Effects of a polar stratosphere cloud parameterization on ozone depletion due to stratospheric aircraft in a two-dimensional model
[HTN-95-A1038] p 443 A95-84543

COO, DENNIS

Advanced flight computer. Special study
[NASA-CR-198165] p 449 N95-27246

COOK, A. B.

Artificial neural networks for predicting nonlinear dynamic helicopter loads
[HTN-95-51678] p 404 A95-85060

CORBETT, N. C.

Control requirements for the RB 211 low-emission combustion system
[BTN-94-EIX95011441244] p 416 A95-84201

CORREA, S.

Combustion system CFD modeling at GE Aircraft Engines p 439 N95-27889

COUSINS, W. T.

Pressure and temperature distortion testing of a two-stage centrifugal compressor
[BTN-94-EIX95011441250] p 431 A95-84207

COX, B. N.

Fundamental concepts in the suppression of delamination buckling by stitching p 426 N95-28486

COX, CAREY F.

General solution procedure for flows in local chemical equilibrium
[HTN-95-42329] p 404 A95-86158

COX, R. A.

An overview of the EASOE campaign
[HTN-95-00702] p 443 A95-86272

COXON, B. R.

Impact damage resistance of composite fuselage structure, part 1 p 399 N95-28482

CREWELL, S.

Aircraft measurements of CLO and HCL during EASOE 1991/92
[HTN-95-00721] p 444 A95-86291

CROUCH, KEITH E.

Aircraft fuel system lightning protection design and qualification test procedures development
[AD-A288401] p 380 N95-26497

CROUSE, PATRICK

The effect of high lift to drag ratio on aerobraking p 415 A95-85807

CROWLEY, JOHN S.

The effects of UH-1 experience on UH-60 simulator performance: A preliminary study
[AD-A289457] p 391 N95-26993

CUCINOTTA, FRANCIS A.

Radiation safety aspects of commercial high-speed flight transportation
[NASA-TP-3524] p 453 N95-26427

CUESTA, JUAN D.

Modeling helicopter blade dynamics using a modified Myklestad-Prohl transfer matrix method
[AD-A289891] p 400 N95-28626

CULSHAW, BRIAN

SMART materials: Surfaces, transforms and interfaces. The commensurate engineering dimension
[AD-A289598] p 442 N95-28649

D**DACRES, CHESTER M.**

The use of electrochemistry and ellipsometry for identifying and evaluating corrosion on aircraft
[AD-A288536] p 381 N95-27186

DAHL, MILO D.

Supersonic coaxial jet noise predictions
[NASA-TM-106917] p 451 N95-26801

DAHLMAN, CARL J.

The value of simulation for training
[AD-A289174] p 411 N95-26556

DALTON, K. K.

Pressure and temperature distortion testing of a two-stage centrifugal compressor
[BTN-94-EIX95011441250] p 431 A95-84207

- DANCEY, C. L.**
Computational/experimental investigation of staged injection into a Mach 2 flow
[HTN-95-51646] p 432 A95-85028
- DANIELS, CHARLES L., II**
Comparison of fixed wing aircraft algorithms for JANUS
[AD-A288503] p 389 N95-26652
- DANILIN, MICHAEL Y.**
Evolution of the concentrations of trace species in an aircraft plume: Trajectory study
[HTN-95-A1044] p 443 A95-84549
- DASTIN, S.**
Comparison of resin film infusion, resin transfer molding, and consolidation of textile preforms for primary aircraft structure p 425 N95-28477
- DAVID, C.**
Airborne lidar observation of mountain-wave-induced polar stratospheric clouds during EASOE
[HTN-95-00738] p 444 A95-86308
- DAVIS, D. D., JR.**
Technology integration box beam failure study
p 441 N95-28468
- DAVIS, JOHN G., JR.**
Overview of the ACT program p 424 N95-28463
- DAVIS, M. J.**
The development of an engineering standard for composite repairs p 396 N95-27528
- DAVIS, R. C.**
Technology integration box beam failure study
p 441 N95-28468
- DE TROIA, R.**
Matrix fraction approach for finite-state aerodynamic modeling
[BTN-95-EIX95262694311] p 365 A95-85482
- DE ZAFRA, R. L.**
An overview of millimeter-wave spectroscopic measurements of chlorine monoxide at Thule, Greenland, February-March, 1992: Vertical profiles, diurnal variation, and longer-term trends
[HTN-95-00722] p 444 A95-86292
- DEATON, JERRY W.**
Test and analysis results for composite transport fuselage and wing structures p 398 N95-28470
- DECKER, DOUGLAS D.**
Flight control design using mixed H2/micron optimization
[AD-A289288] p 410 N95-27036
- DECKERT, WALLACE H.**
The lift-lan aircraft: Lessons learned
[NASA-CR-196694] p 392 N95-27143
- DEETER, THOMAS E.**
Survey and implementation of commercial manual controllers for a generic telerobotics architecture
[AD-A289215] p 449 N95-26990
- DEIVERT, ROBERT A.**
An analysis of the KC-135 three-person cockpit
[AD-A289540] p 390 N95-26873
- DELFRATE, JOHN H.**
NASA Dryden flow visualization facility
[NASA-TM-4631] p 449 N95-27914
- DEVENPORT, WILLIAM J.**
Flow structure generated by perpendicular blade vortex interaction and implications for helicopter noise predictions
[NASA-CR-198590] p 377 N95-28193
- DEXTER, H. BENSON**
Resin transfer molding of textile preforms for aircraft structural applications p 421 N95-28276
Recent progress in NASA Langley textile reinforced composites program p 425 N95-28475
- DIAZ, MILTON E.**
The photo-realistic AFIT virtual cockpit
[AD-A289376] p 390 N95-26876
- DIBERARDINO, M.**
Field repair materials for naval aircraft
p 394 N95-27514
- DIMICHELE, ROBERTO**
Proceedings of the AIAA/FAA joint symposium on general aviation systems
[AD-A289830] p 368 N95-28610
- DINICOLA, ALBERT J.**
Static and fatigue testing of full-scale fuselage panels fabricated using a Therm-X(R) process
p 420 N95-28270
- DINU, ADRIAN**
Direct boundary integral equations method to subsonic flow with circulation past thin airfoils in ground effect
[BTN-95-EIX95242673940] p 365 A95-82224
- DOANE, WILLIAM J.**
Development of a low-cost, modified resin transfer molding process using elastomeric tooling and automated preform fabrication p 420 N95-28268
- DOGGETT, ROBERT V., JR.**
Flutter clearance flight tests of an OV-10A airplane modified for wake vortex flight experiments
[NASA-TM-109168] p 366 N95-26381
- DOHME, JACK A.**
Intelligent flight trainer for initial rotary wing training
[SAE PAPER 932536] p 386 A95-84558
Automated hover training: An empirical evaluation
[SAE PAPER 932536] p 379 A95-84559
- DOLVIN, DOUGLAS J.**
Structural design optimization with survivability dependent constraints application: Primary wing box of a multi-role fighter p 398 N95-28440
- DONNELLAN, T. M.**
Navy composite maintenance and repair experience
p 424 N95-28446
- DOSANJH, DARSHAN**
The noise reduction potential of dual-stream coaxial rectangular improperly expanded jet flows
[NASA-CR-197820] p 437 N95-26995
- DOST, E. F.**
Impact damage resistance of composite fuselage structure, part 1 p 399 N95-28482
- DOUGLASS, ANNE R.**
Effects of a polar stratosphere cloud parameterization on ozone depletion due to stratospheric aircraft in a two-dimensional model
[HTN-95-A1038] p 443 A95-84543
- DOW, MARVIN B.**
Development of stitched/RTM composite primary structures p 425 N95-28469
- DOWELL, EARL H.**
Nonlinear dynamics and aeroelasticity of rotorcraft in forward flight
[AD-A291714] p 400 N95-28504
- DOWNEN, TROY**
Preliminary design problems and solutions for a supersonic oblique all-wing transport aircraft
p 390 N95-26942
Design of a high altitude long endurance aircraft with manufacturing considerations p 391 N95-26947
Prevention and control of inlet unstart using an SR-71 simulation p 367 N95-26948
- DRAGOS, LAZAR**
Direct boundary integral equations method to subsonic flow with circulation past thin airfoils in ground effect
[BTN-95-EIX95242673940] p 365 A95-82224
- DRUET, MICHELINE**
Composite repair of metallic airframe: Twenty years of experience p 393 N95-27508
- DUKE, M. R., JR.**
Numerical investigation of cylinder wake flow with a rear stagnation jet
[HTN-95-51669] p 433 A95-85051
- DURKIN, E.**
Flex cycle combustor development and demonstration
[BTN-94-EIX95011441245] p 417 A95-84202
- DUTTON, JAMES P., JR.**
Development of a nonlinear simulation for the McDonnell Douglas F-15 Eagle with a longitudinal TECS control-law
[AD-A288610] p 388 N95-26481
- E**
- EARHART, E.**
Bearing defect signature analysis using advanced nonlinear signal analysis in a controlled environment
[NASA-TM-108491] p 441 N95-28364
- EATON, JOHN K.**
Near field of a coaxial jet with and without axial excitation
[HTN-95-42332] p 372 A95-86161
Active open-loop control of particle dispersion in round jets
[HTN-95-42334] p 372 A95-86163
- EBEL, ADOLF**
Evolution of the concentrations of trace species in an aircraft plume: Trajectory study
[HTN-95-A1044] p 443 A95-84549
- ECKLUND, ROWENA H.**
Composite intermediate case manufacturing scale-up for advanced engines p 406 N95-28275
- EDLOW, RALPH**
COINS: A composites information database system
p 453 N95-28465
- EGOLF, T. ALAN**
Evaluation of a doubly-swept blade tip for rotorcraft noise reduction
[NASA-CR-189677] p 452 N95-28264
- EGUCHI, KUNIHISA**
An advanced scramjet propulsion concept for A 350 MG SSTO space plane p 402 A95-82325
- EHLEN, R. J.**
Development of composite carrythrough bulkhead
p 423 N95-28438
- EHRET, G.**
Two dimensional stratospheric aerosol distributions during EASOE
[HTN-95-00726] p 444 A95-86296
- EIDE, PETER K.**
Implementation and demonstration of a multiple model adaptive estimation failure detection system for the F-16
[AD-A289301] p 391 N95-27042
- EISENBIES, CHRISTOPHER L.**
Classification of ultra high range resolution radar using decision boundary analysis
[AD-A289378] p 437 N95-26877
- EJIRI, M.**
Polar Patrol Balloon system and preliminary experimental results p 368 A95-82513
- EKLUND, D. R.**
Computational/experimental investigation of staged injection into a Mach 2 flow
[HTN-95-51646] p 432 A95-85028
- ELALDI, F.**
Scar joint technique with cocured and precured patches for composite repair p 396 N95-27524
- ELBERN, HENDRIK**
Evolution of the concentrations of trace species in an aircraft plume: Trajectory study
[HTN-95-A1044] p 443 A95-84549
- EMAMI, SAIED**
Experimental investigation of inlet-combustor isolators for a dual-mode scramjet at a Mach number of 4
[NASA-TP-3502] p 407 N95-28343
- EMERY, Y.**
Airborne lidar observation of mountain-wave-induced polar stratospheric clouds during EASOE
[HTN-95-00738] p 444 A95-86308
- EMMONS, L. K.**
An overview of millimeter-wave spectroscopic measurements of chlorine monoxide at Thule, Greenland, February-March, 1992: Vertical profiles, diurnal variation, and longer-term trends
[HTN-95-00722] p 444 A95-86292
- F**
- FAETH, G. M.**
Sphere wakes at moderate Reynolds numbers in a turbulent environment
[HTN-95-42331] p 372 A95-86160
- FALEN, GERALD L.**
Analysis and simulation of narrowband GPS jamming using digital excision temporal filtering
[AD-A289328] p 383 N95-26898
- FARLEY, G. L.**
Technology integration box beam failure study
p 441 N95-28468
- FARMAN, J. C.**
An overview of the EASOE campaign
[HTN-95-00702] p 443 A95-86272
- FASANELLA, EDWIN L.**
Effects of floor location on response of composite fuselage frames p 423 N95-28439
- FAUCON, P.**
An overview of the EASOE campaign
[HTN-95-00702] p 443 A95-86272
- FAY, RUSSELL**
Application of advanced material systems to composite frame elements p 422 N95-28432
- FEDRO, MARK J.**
Characterization and manufacture of braided composites for large commercial aircraft structures
p 426 N95-28478
- FEHRENBACHER, LARRY L.**
Ceramic composite combustor cans for expendable turbine engines
[AD-A289551] p 407 N95-28646
- FEINER, L. J.**
Evaluation of all-electric secondary power for transport aircraft
[NASA-CR-189077] p 441 N95-27999
- FENNO, C. C., JR.**
Response of multi-panel assembly to noise from a jet in forward motion
[NASA-CR-198164] p 442 N95-28673
- FENTRESS, MICHAEL L.**
Unique considerations in the design and experimental evaluation of tailored wings with elastically produced chordwise camber p 423 N95-28436
- FERGIONE, J. A.**
T-45A high angle attack testing
[HTN-95-81499] p 386 A95-85213
- FERGUSON, J. S.**
Composite repair issues on the CF-18 aircraft
p 395 N95-27518

- FERRARA, GUS**
Proceedings of the AIAA/FAA joint symposium on general aviation systems
[AD-A289830] p 368 N95-28610
- FIELD, FRANK R., III**
The potential for CMCs to replace superalloys in engine exhaust ducts
[HTN-95-42298] p 418 A95-84992
- FINN, SCOTT R.**
Compressive strength of damaged and repaired composite plates
p 442 N95-28484
- FIGORE, ERIC E.**
Pilot rating scale for aircraft handling qualities
[HTN-95-42269] p 380 A95-84963
- FIORUCCI, T.**
Bearing defect signature analysis using advanced nonlinear signal analysis in a controlled environment
[NASA-TM-108491] p 441 N95-28364
- FISCHER, H.**
Airborne measurements during the European Arctic Stratospheric Ozone Experiment column amounts of HNO₃ and O₃ derived from FTIR emission sounding
[HTN-95-00742] p 445 A95-86312
- FLESIA, C.**
Airborne lidar observation of mountain-wave-induced polar stratospheric clouds during EASOE
[HTN-95-00738] p 444 A95-86308
- FLETCHER, D. G.**
Computational/experimental investigation of staged injection into a Mach 2 flow
[HTN-95-51646] p 432 A95-85028
- FLORES, R. R.**
Evaluation of all-electric secondary power for transport aircraft
[NASA-CR-189077] p 441 N95-27999
- FOERSCHING, H.**
Aeroelastic stability of cascades in turbomachinery
[HTN-95-61156] p 405 A95-86255
- FOLTA, DAVID C.**
Reentry analysis for low Earth orbiting spacecraft
p 415 A95-85774
- FOREMAN, C. R.**
C-130 Advanced Technology Center wing box conceptual design/cost study
p 423 N95-28437
- FORREST, WILLIAM C.**
Creating an alternative parameter optimization method (APO)
p 375 N95-26946
- FOSTER, LUCAS E.**
Extension to the dynamic modeling of the large angle magnetic suspension test fixture
[NASA-CR-197801] p 411 N95-26768
- FOWLER, T. K.**
Whirl plus tilt
[DE95-007948] p 452 N95-28108
- FRAILLEY, JAMES A.**
Rapid repair of large area damage to contoured aircraft structures
p 394 N95-27516
- FRAME, C. S.**
Composite repair of composite structures
p 395 N95-27521
- FRANGANILLO, A.**
Repairs of CFC primary structures
p 396 N95-27527
- FRANK, JASON**
Preliminary results and research capabilities of a new jet facility at the University of Kansas
p 412 N95-26951
- FRANKLIN, JAMES A.**
Simulation model of the integrated flight/propulsion control system, displays, and propulsion system for ASTOVL lift-fan aircraft
[NASA-TM-108866] p 405 N95-26412
- FRANSEN, LAWRENCE J.**
Speech analysis and synthesis based on pitch-synchronous segmentation of the speech waveform
[AD-A288824] p 435 N95-26349
- FRASER, K. F.**
Characteristics of the turbine inlet temperature sensing circuit for the T56 turbo-prop engine
[DSTO-TR-0095] p 405 N95-26424
- FREEMAN, W.**
Designers' unified cost model
p 424 N95-28464
- FRIEDMANN, P. P.**
Aeroelasticity and structural optimization of composite helicopter rotor blades with swept tips
[NASA-CR-4665] p 397 N95-28262
- FRIEDRICH, HORST E.**
Forming and bonding techniques for high-strength aluminum alloys
[HTN-95-20605] p 418 A95-84786
- FRY, H. A.**
A laboratory scale supersonic combustive flow system
[DE95-006347] p 420 N95-27851
- FUJII, MASAMI**
Development and flight results of fiber reinforced balloon
p 384 A95-82511
- FUJII, R.**
Polar Patrol Balloon system and preliminary experimental results
p 368 A95-82513
- FUJITA, TOSHIMI**
Experimental investigation of static and dynamic ground effect on HOPE ALFLEX vehicle
[NAL-TR-1236] p 388 N95-26525
- FUJIWARA, TOSHI**
An experimental study on radiation from strong shock layer
p 368 A95-82421
- FUJIWARA, TSUTOMU**
An advanced scramjet propulsion concept for A 350 MG SSTO space plane
p 402 A95-82325
- FULLER, C. R.**
Artificial neural networks for predicting nonlinear dynamic helicopter loads
[HTN-95-51678] p 404 A95-85060
- FURRER, R.**
Mapping of forest fire damages using imaging spectroscopy
p 442 A95-83627
- G**
- GAMMAL, YOUSSEF EL**
International cooperation in standardization
p 452 A95-82665
- GANDHI, FARHAN**
An analytical model for a nonlinear elastomeric lag damper and its effect on aeromechanical stability in Hover
[HTN-95-61076] p 369 A95-83660
- GARABEDIAN, PAUL R.**
Computational fluid dynamics and transonic flow
[AD-A288962] p 436 N95-26405
- GARCIANUNEZ, H.**
Repairs of CFC primary structures
p 396 N95-27527
- GARDINER, PETER T.**
SMART materials: Surfaces, transforms and interfaces. The commensurate engineering dimension
[AD-A289598] p 442 N95-28649
- GASICK, MICHAEL F.**
Analysis techniques for the prediction of springback in formed and bonded composite components
p 421 N95-28289
- GATTO, J. L.**
Stationary premixed flames in spherical and cylindrical geometries
[HTN-95-42336] p 418 A95-86165
- GDOUTOS, E. E.**
Evaluation of patch effectiveness in repairing aircraft components
p 394 N95-27513
- GEE, KEN**
Computational analysis of forebody tangential slot blowing on the high alpha research vehicle
[NASA-CR-197754] p 389 N95-26591
- GELL, MAURICE**
Applying nanostructured materials to future gas turbine engines
[HTN-95-11909] p 404 A95-85990
- GHIRINGHELLI, G. L.**
Matrix fraction approach for finite-state aerodynamic modeling
[BTN-95-EIX95262694311] p 365 A95-85482
- GIBBONS, ANDREW S.**
New tools for creating instruction and simulations
[SAE PAPER 932600] p 380 A95-84572
- GILLAN, MARK A.**
Computational analysis of buffet alleviation in viscous transonic flow over a porous airfoil
[BTN-95-EIX95262694321] p 366 A95-85492
- GILLET, DAVE**
Strategy in the commercial aircraft industry in the United States: A comparison of decisionmaking by McDonnell-Douglas and Boeing aircraft companies from 1977-1983
[AD-A288289] p 366 N95-26409
- GLATTHOR, N.**
Airborne measurements during the European Arctic Stratospheric Ozone Experiment column amounts of HNO₃ and O₃ derived from FTIR emission sounding
[HTN-95-00742] p 445 A95-86312
- GLEGG, STEWART A. L.**
Flow structure generated by perpendicular blade vortex interaction and implications for helicopter noise predictions
[NASA-CR-198590] p 377 N95-28193
- GLUCK, R.**
Design of a real-time wind turbine simulator using a custom parallel architecture
p 449 N95-27979
- GODIN, S.**
Airborne lidar observation of mountain-wave-induced polar stratospheric clouds during EASOE
[HTN-95-00738] p 444 A95-86308
- GOLDHAGEN, PAUL**
Radiation safety aspects of commercial high-speed flight transportation
[NASA-TP-3524] p 453 N95-26427
- GOLUB, ROBERT A.**
Aircraft noise prediction program theoretical manual: Rotorcraft System Noise Prediction System (ROTONET), part 4
[NASA-TM-83199-PT-4] p 451 N95-26392
- GONSALVES, PAUL G.**
Intelligent flight trainer for initial rotary wing training
[SAE PAPER 932536] p 386 A95-84558
- GORANSON, ULF G.**
Elements of structural integrity assurance
p 387 A95-85896
- GORBATKIN, S. M.**
Permanent magnet electron cyclotron resonance plasma source with remote window
[BTN-95-EIX95242674338] p 450 A95-82176
- GORDNER, RAYMOND E.**
Crossflow topology of vortical flows
[HTN-95-51664] p 432 A95-85046
- GOVINDARAJ, T.**
Operator modeling in commercial aviation: Cognitive models, intelligent displays, and pilot's assistants
[NASA-CR-198609] p 401 N95-28203
- GRAESSER, D.**
Local design optimization for composite transport fuselage crown panels
p 398 N95-28473
- GRANDAGE, J. M.**
A review of Australian and New Zealand investigations on aeronautical fatigue during the period Apr. 1993 - Mar. 1995
[AR-009-202] p 397 N95-27918
- GRANDE, D. H.**
Impact damage resistance of composite fuselage structure, part 1
p 399 N95-28482
- GRANT, C.**
Composite fuselage crown panel manufacturing technology
p 399 N95-28474
- GRANT, CARROLL G.**
Advanced tow placement of composite fuselage structure
p 420 N95-28271
- GRANT, CATHERINE**
Design of a high altitude long endurance aircraft with manufacturing considerations
p 391 N95-26947
- GRAY, P. M.**
Probabilistic design of advanced composite structure
p 424 N95-28443
- GRAY, ROBERT A.**
An integrated GPS/INS/BARO and radar altimeter system for aircraft precision approach landings
[AD-A289280] p 383 N95-26985
- GREGOREK, G. M.**
Comparative wind tunnel test at high Reynolds numbers of NACA 64 621 airfoils with two aileron configurations
p 377 N95-27977
- GREYVENSTEIN, G. P.**
Differentiation of density in compressible flow for a pressure-based approach
[HTN-95-42349] p 373 A95-86178
- GRIFFIN, C. F.**
Structural testing of the technology integration box beam
p 441 N95-28467
- GROSKO, J.**
Structural modification and repair of C-130 wing structure using bonded composites
p 394 N95-27512
- GROSVELD, F. W.**
Measurement and prediction of broadband noise from large horizontal axis wind turbine generators
p 451 N95-27990
- GRUNWALD, ARTHUR J.**
Advanced interactive display formats for terminal area traffic control
[NASA-CR-198576] p 384 N95-28188
- GUENTHER, G.**
Composite repair of a CF18: Vertical stabilizer leading edge
p 395 N95-27517
- GULDE, T.**
Airborne measurements during the European Arctic Stratospheric Ozone Experiment column amounts of HNO₃ and O₃ derived from FTIR emission sounding
[HTN-95-00742] p 445 A95-86312
- GUTMARK, EPHRAIM**
Suppressor of oscillations in airframe cavities
[AD-D017265] p 388 N95-26507
- GUTOWSKI, T.**
Designers' unified cost model
p 424 N95-28464

H

HAFFNER, STEPHEN W.

Noise exposure reduction of advanced high-lift systems
[NASA-CR-195077] p 452 N95-28670

HAGENIERS, O. L.

Characterization of corrosion and development of a breadboard of a D sight aircraft inspection system, phase 1
[AD-A288347] p 380 N95-26527

HAHN, E. J.

Effect of squeeze film damper land geometry on damper performance
[HTN-95-92247] p 434 A95-85291

HAJNAL, FERENC

Radiation safety aspects of commercial high-speed flight transportation
[NASA-TP-3524] p 453 N95-26427

HALL, RONALD G.

Development of a low-cost, modified resin transfer molding process using elastomeric tooling and automated preform fabrication p 420 N95-28268

HALL, WILLIAM

Weather And Radar Processor (WARP) Test and Evaluation Master Plan (TEMP)
[AD-A288280] p 445 N95-26453

HALLETT, JOHN

Replicator for characterization of cirrus and polar stratospheric cloud particles
[NASA-CR-197785] p 445 N95-26669

HALLIWELL, N. A.

Vibration measurements on rotating machinery using laser Doppler velocimetry
[BTN-94-EIX95011440597] p 429 A95-82986

HAMMON, COLIN P.

The value of simulation for training
[AD-A289174] p 411 N95-26556

HANER, D.

Airborne lidar observation of mountain-wave-induced polar stratospheric clouds during EASOE
[HTN-95-00738] p 444 A95-86308

HANIGOSKY, JOHN A.

Ceramic composite combustor cans for expendable turbine engines
[AD-A289551] p 407 N95-28646

HANSFORD, ROBERT E.

Considerations in the development of the coupled rotor fuselage model
[HTN-95-61077] p 370 A95-83661

HANSMAN, R. JOHN

Part-task simulator evaluations of advanced terrain displays
[SAE PAPER 932570] p 401 A95-84567

HANUS, GARY J.

Design features of the NAL ramjet engine test facility
p 410 A95-82319

HARDEN, JOHN H., JR.

Naval Aviation System TEAM mapping, charting, and geodesy handbook
[AD-A288590] p 446 N95-26841

HARRIS, C. E.

Tension fracture of laminates for transport fuselage. Part 1: Material screening p 398 N95-28471

HARRIS, CHARLES E.

Recent progress in NASA Langley textile reinforced composites program p 425 N95-28475

HARRIS, M. M.

Flex cycle combustor development and demonstration
[BTN-94-EIX95011441245] p 417 A95-84202

HARRIS, N. R. P.

An overview of the EASOE campaign
[HTN-95-00702] p 443 A95-86272

HARRIS, W. L.

Anechoic wind tunnel study of turbulence effects on wind turbine broadband noise p 451 N95-27992

HARRISON, L.

Digital systems validation. Chapter 20 Artificial Intelligence with applications for aircraft. Handbook, volume 2
[AD-A288492] p 448 N95-26638

HARTFIELD, R. J., JR.

Computational/experimental investigation of staged injection into a Mach 2 flow
[HTN-95-51646] p 432 A95-85028

HARTFIELD, ROY J., JR.

Quantitative investigation of compressible mixing: Staged transverse injection into Mach 2 flow
[HTN-95-42330] p 404 A95-86159

HARTMAN, KATHY R.

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[NASA-CP-3299] p 416 N95-27763

HARTOGH, P.

Aircraft measurements of CLO and HCL during EASOE 1991/92
[HTN-95-00721] p 444 A95-86291

HARVEY, GALE A.

Hardware cleanliness methodology and certification
p 419 N95-27656

HARVEY, GARY

Micro-time stress measurement device development
[AD-A289511] p 448 N95-26845

HASKO, GREGORY H.

Resin transfer molding of textile preforms for aircraft structural applications p 421 N95-28276

HAVEN, CHRISTINE E.

Quiet-flow Ludewig tube for high-speed transition research
[BTN-95-EIX95262694309] p 370 A95-85480

HAYASAKA, TADAHIRO

Air truth validation of cloud albedo estimated from NOAA advanced very high resolution radiometer data
[HTN-95-A1021] p 443 A95-84526

HAYER, M. EHTESHAM

Structure of supersonic jet flow and its radiated sound
[HTN-95-51645] p 431 A95-85027

HAYNES, TIMOTHY S.

Transition correlations in three-dimensional boundary layers
[HTN-95-51648] p 432 A95-85030

HAZLEWOOD, RICHARD

Design of a high altitude long endurance aircraft with manufacturing considerations p 391 N95-26947

HE, HONGQING

Numerical analysis of flow field around gas rudder
p 407 A95-82333

HEATH, J. B. R.

Bonded composite repair of thin metallic materials: Variable load amplitude and temperature cycling effects
p 393 N95-27509

HEFAZI, HAMID

Predicting stall and post-stall behavior of airfoils at low mach numbers
[BTN-95-EIX95262694297] p 365 A95-85468

HEIMERDINGER, M. W.

Repair technology for thermoplastic aircraft structures
p 395 N95-27519

HEINZE, BILL

Maintenance programs
[HTN-95-92310] p 365 A95-85354

HENMI, MAKOTO

An experimental study on radiation from strong shock layer p 368 A95-82421

HEMSCH, MICHAEL J.

Measurements of store forces and moments and cavity pressures for a generic store in and near a box cavity at subsonic and transonic speeds
[NASA-TM-4611] p 378 N95-28241

HENDRICKS, R. C.

Numerical analysis of intra-cavity and power-stream flow interaction in multiple gas-turbine disk-cavities
[NASA-TM-106886] p 407 N95-28344

HENDRICKS, ROBERT C.

Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics
[NASA-TM-106685] p 416 N95-27434

HENDRIX, A. M.

Development of a coding form for approach control/pilot voice communications
[DOT/FAA/AM-95/15] p 384 N95-28540

HENSEL, EDWARD

Demonstration study of hierarchical control of fluid-dynamic phenomena
[AD-A289341] p 437 N95-26751

HESSHEIMER, MICHAEL

The large radius track centrifuge concept as an acceleration research and simulation device
p 379 A95-84560

HILMES, C. L.

TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual
[NASA-CR-4349] p 377 N95-28230

TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document
[NASA-CR-4348] p 378 N95-28265

HINADA, MOTOKI

The aerodynamic characteristics of cup-like body in supersonic flow p 427 A95-82407

Atmospheric reentry flight test of winged space vehicle p 414 A95-82483

Reentry technology experiment on the first mission of reentry capsule 'EXPRESS' p 414 A95-82499

Development and flight results of fiber reinforced balloon p 384 A95-82511

HIRAKI, KOJU

The aerodynamic characteristics of cup-like body in supersonic flow p 427 A95-82407

HIRASAWA, T.

Polar Patrol Balloon system and preliminary experimental results p 368 A95-82513

HIRSA, A.

Measurements of vortex pair interaction with a clean or contaminated free surface
[BTN-94-EIX95011441063] p 429 A95-82798

HOFFMAN, JOHN A.

Design of a real-time wind turbine simulator using a custom parallel architecture p 449 N95-27979

HOFFMAN, PETER M.

Design and synthesis of a real-time controller for an unmanned air vehicle
[AD-A289134] p 408 N95-26555

HOLDRIDGE, GEOFFREY M.

JTEC/WTEC annual report and program summary: 1993/94
[NASA-CR-198563] p 454 N95-28038

HOLLO, STEVEN D.

Quantitative investigation of compressible mixing: Staged transverse injection into Mach 2 flow
[HTN-95-42330] p 404 A95-86159

HOPFNER, M.

Airborne measurements during the European Arctic Stratospheric Ozone Experiment column amounts of HNO₃ and O₃ derived from FTIR emission sounding
[HTN-95-00742] p 445 A95-86312

HORISAWA, HIDEYUKI

Studies on plasma jet igniters p 403 A95-82680

HORWATH, JOHN

Partial discharge testing of high voltage wiring harness for airborne displays
[AD-A289150] p 401 N95-27003

HOSP, THEODORE J.

Control system design for the MOD-5A 7.3 mW wind turbine generator p 440 N95-27985

HOZUMI, KOUICHI

Hypersonic wind tunnel test of sidewall compression type scramjet inlet p 410 A95-82320

HSIAO, FEI-BIN

High angle-of-attack airfoil performance improvement by internal acoustic excitation
[HTN-95-42347] p 372 A95-86176

HU, ZHAO-FENG

Nonlinear decoupling control study for aircraft maneuvering flight
[HTN-95-71130] p 408 A95-83491

HUANG, STEVE

An exploratory application of neural networks for airfoil design p 448 N95-26943

HUANG, XU-SHENG

Non-linear viscoelastic-plastic constitutive relations for an aeronautical PMMA
[HTN-95-71132] p 385 A95-83493

HUBBARD, H. H.

Measurement and prediction of broadband noise from large horizontal axis wind turbine generators
p 451 N95-27990

HUGO, G. R.

Scarf repairs to graphite/epoxy components p 396 N95-27523

HUNT, M. L.

Flowfield measurements in supersonic film cooling including the effect of shock-wave interaction
[HTN-95-42337] p 405 A95-86166

HUSSAIN, FAZLE

Basic studies in turbulent shear flows
[AD-A289145] p 437 N95-26998

HYLANDER, KEN

Maintenance programs
[HTN-95-92310] p 365 A95-85354

IANNELLI, G. S.

Accuracy and efficiency assessments for a weak statement CFD algorithm for high-speed aerodynamics
[BTN-94-EIX95011441238] p 370 A95-84195

ICHIKAWA, T.

Development of 70MW class superconducting generators
[BTN-94-EIX95011440854] p 429 A95-82905

ILCEWICZ, L.

Designers' unified cost model p 424 N95-28464

ILCEWICZ, L. B.

Tension fracture of laminates for transport fuselage. Part 1: Material screening p 398 N95-28471

Local design optimization for composite transport fuselage crown panels p 398 N95-28473

Impact damage resistance of composite fuselage structure, part 1 p 399 N95-28482

ILIAKOPOULOU, ENNY

Maintenance programs
[HTN-95-92310] p 365 A95-85354

IMAI, KIYAMU

Experiment and analysis on heat transfer of a scramjet leading edge model p 403 A95-82420

IN, K. M.

Two-dimensional viscous flow past a flat plate [HTN-95-42210] p 430 A95-84026

INAGAKI, TOSHIHARU

Flight evaluation of DGPS and DGPS-INS navigation systems p 382 A95-82462

INATANI, YOSHIFUMI

The aerodynamic characteristics of cup-like body in supersonic flow p 427 A95-82407
Air data sensors for atmospheric reentry flight test of winged space vehicle p 413 A95-82412
Atmospheric reentry flight test of winged space vehicle p 414 A95-82483
Reentry technology experiment on the first mission of reentry capsule 'EXPRESS' p 414 A95-82499
Development and flight results of fiber reinforced balloon p 384 A95-82511

INOUE, YASUTOSHI

NAL aerothermodynamic probing and CFD verification mission in OREX experiment p 368 A95-82413

ISHII, MASAHIRO

Life evaluation of a low power arcjet thruster p 403 A95-82337

ISHII, NOBUAKI

Development and flight results of fiber reinforced balloon p 384 A95-82511

ISHIKAWA, KAZUTOSHI

Flight evaluation of DGPS and DGPS-INS navigation systems p 382 A95-82462
Flight evaluation of GPS/DGPS sensor systems installed in NAL Do228 [NAL-TR-1230] p 382 N95-26585

ITO, TAKESHI

Hypersonic wind tunnel test of sidewall compression type scramjet inlet p 410 A95-82320

ITOH, KATSUHIRO

Experiment and analysis on heat transfer of a scramjet leading edge model p 403 A95-82420

ITOH, NOBUTAKE

Multiple instabilities of three-dimensional boundary layers along a concave wall [HTN-95-71126] p 429 A95-83487
Observation of traveling waves in the three-dimensional boundary layer along a yawed cylinder [HTN-95-61064] p 430 A95-83648
Instability of three-dimensional boundary layers due to streamline curvature [HTN-95-61070] p 430 A95-83654

IWASAKI, AKIHITO

Experimental investigation of static and dynamic ground effect on HOPE ALFLEX vehicle [NAL-TR-1236] p 388 N95-26525

IWATA, JIRO

The near-wake flow behavior of an oscillating airfoil with modified trailing edge p 375 N95-26953

J

JACKMAN, CHARLES H.

Effects of a polar stratosphere cloud parameterization on ozone depletion due to stratospheric aircraft in a two-dimensional model [HTN-95-A1038] p 443 A95-84543

JACKSON, ANTHONY C.

Advanced textile applications for primary aircraft structures p 399 N95-26476

JACOBS, E. W.

Observed acoustic and aeroelastic spectral responses of a MOD-2 turbine blade to turbulence excitation p 451 N95-27991

JAIN, AMOLAK C.

Rarefied gas effects on aerobraking/reentry vehicles with wakes [NASA-CR-196586] p 415 N95-27093

JANOWITZ, J.

Digital systems validation. Chapter 20 Artificial Intelligence with applications for aircraft. Handbook, volume 2 [AD-A288492] p 448 N95-26638

JARFALL, L.

Verification of the damage tolerance of a fighter aircraft p 388 A95-85897

JEGLEY, DAWN

Effect of low-speed impact damage and damage location on behavior of composite panels p 426 N95-28481

JESKE, JAMES A.

Flightpath synthesis and HUD scaling for V/STOL terminal area operations [NASA-TM-110348] p 383 N95-26587

JOHNSON, BONNIE L.

Full span flaperons for a biplane p 391 N95-26954

JOHNSON, ERIC R.

Load transfer in the stiffener-to-skin joints of a pressurized fuselage [NASA-CR-198610] p 439 N95-27865

JOHNSON, F. T.

TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual [NASA-CR-4349] p 377 N95-28230

TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document [NASA-CR-4348] p 378 N95-28265

JOHNSON, JERRY

Application of damage tolerance methodology in certification of the Piaggio P-180 Avanti p 399 N95-28480

JOHNSTON, G. W.

Compressible Navier-Stokes computations of multielement airfoil flows using multiblock grids [HTN-95-42327] p 371 A95-86156

JOHNSTON, NORMAN J.

Recent progress in NASA Langley textile reinforced composites program p 425 N95-28475

JONES, JESSE

Precision landing system mathematical modeling study report for Andrews Air Force Base, runway 19L, Camp Springs, MD [AD-A289015] p 384 N95-27903

JONES, LISA E.

Effects of floor location on response of composite fuselage frames p 423 N95-28439

JONES, R. L.

An overview of the EASOE campaign [HTN-95-00702] p 443 A95-86272

JONES, R. R., III

Screech tones from free and ducted supersonic jets [HTN-95-51647] p 432 A95-85029

JOST, G. S.

A review of Australian and New Zealand investigations on aeronautical fatigue during the period Apr. 1993 - Mar. 1995 [AR-009-202] p 397 N95-27918

JU, YIGUANG

Ignition analysis of hydrogen/air mixture in supersonic mixing layer p 416 A95-82301

JUHANY, K. A.

Flowfield measurements in supersonic film cooling including the effect of shock-wave interaction [HTN-95-42337] p 405 A95-86166

JUMPER, STEPHEN J.

Aircraft noise prediction program theoretical manual: Rotorcraft System Noise Prediction System (ROTONET), part 4 [NASA-TM-83199-PT-4] p 451 N95-26392

K

KADOKURA, A.

Polar Patrol Balloon system and preliminary experimental results p 368 A95-82513

KADOWAKI, M.

Study on the turbine vane and blade for a 1500 C class industrial gas turbine [BTN-94-EIX95011441254] p 431 A95-84211

KAHLA, N. BEN

Equivalent beam-column analysis of guyed towers [BTN-95-EIX95262696644] p 435 A95-85519

KAMBLE, S. H.

Mobile domes for TACTIC telescope p 453 A95-86113

KAN, HAN-PIN

Analysis of composite structures with delaminations under combined bending and compression p 422 N95-28429

Reliability analysis of composite structures p 423 N95-28441

KANDBO, STANLEY W.

NASA-Lewis tests Allison ASTOVL nozzle [HTN-95-20603] p 404 A95-84784

KANE, RUSSELL

The legal status and liability of the copilot, part 2 [HTN-95-A0578] p 452 A95-83158

KANG, GEORGE S.

Speech analysis and synthesis based on pitch-synchronous segmentation of the speech waveform [AD-A288824] p 435 N95-26349

KANG, JIAREN

Nonlinear observer and its application in flight control p 447 A95-82449

KANG, KI HO

Electro-hydrostatic actuator controller design using quantitative feedback theory [AD-A289220] p 409 N95-26957

KANNO, YOSHITSUGU

A conceptual design of hypersonic research vehicle with subscale scramjet engine p 384 A95-82482

KARKERA, B. N.

Mobile domes for TACTIC telescope p 453 A95-86113

KARPALA, F.

Characterization of corrosion and development of a breadboard of a D sight aircraft inspection system, phase 1 [AD-A288347] p 380 N95-26527

KARPEL, M.

Stress considerations in reduced-size aeroelastic optimization [BTN-95-EIX95262694313] p 366 A95-85484

KASSAPOGLOU, CHRISTOS

Static and fatigue testing of full-scale fuselage panels fabricated using a Therm-X(R) process p 420 N95-28270

KAUTZ, EDWARD

Analysis of composite structures with delaminations under combined bending and compression p 422 N95-28429

KAWAGUCHI, JUN-ICHIRO

Aero-thermodynamic flight environment at HITEN aerobreaker experiment p 415 A95-82554

KAWAGUCHI, JUN'ICHIRO

How 'HITEN's' aerobraking experiments were carried out p 415 A95-82553

KAWAI, H.

Study on the turbine vane and blade for a 1500 C class industrial gas turbine [BTN-94-EIX95011441254] p 431 A95-84211

KAWAJI, M.

Study of heat transfer rates during quenching of a hot tube under microgravity p 428 A95-82641
Experimental investigation of flow-boiling heat transfer under microgravity p 428 A95-82642

KAWAJI, MASAHIRO

Experimental investigation of composite channel heat pipe operation in micro-gravity environment p 428 A95-82645

KAYLOE, JORDAN R.

EASY-SIM: A visual simulation system software architecture with an Ada 9X application framework [AD-A289325] p 448 N95-26895

KAZUMORI, M.

Development of 70MW class superconducting generators [BTN-94-EIX95011440854] p 429 A95-82905

KEARNS, EDWARD P., III

Air cushioned landing craft (LCAC) based ship to shore movement simulation: A decision aid for the amphibious commander. A (SMMAT) application [AD-A289635] p 436 N95-26722

KELLEY, N. D.

A comparison of measured wind park load histories with the WISPER and WISPERX load spectra [DE95-000295] p 446 N95-27459
Observed acoustic and aeroelastic spectral responses of a MOD-2 turbine blade to turbulence excitation p 451 N95-27991

KENT, J. A.

NASA-ACEE/Boeing 737 graphite-epoxy horizontal stabilizer service p 400 N95-28489

KEOGH, P. S.

The dynamic nature of rotor thermal bending due to unsteady lubricant shearing within a bearing [HTN-95-42091] p 430 A95-83857

KERMAN, B. R.

Fractal properties of whitecaps [HTN-95-92121] p 443 A95-83827

KHODADOUST, ABDOLLAH

Further investigations of icing effects on an advanced high-lift multi-element airfoil [NASA-TM-106947] p 381 N95-27762

KIM, M.-U.

Two-dimensional viscous flow past a flat plate [HTN-95-42210] p 430 A95-84026

KIMBALL, DWAYNE F.

Flying qualities development and flight simulation evaluation of the TW-68 tilt-wing VTOL aircraft [SAE PAPER 932517] p 386 A95-84555

KIRI, NOBUAKI

Studies on gain performance of a combustion driven CO₂ gas dynamic laser p 428 A95-82679

KIRK, R. G.

Thermo-hydrodynamic solution of floating ring seals for high pressure compressors using the finite-element method [HTN-95-92246] p 433 A95-85290

KISH, BRIAN A.

A comparison of the Neal-Smith and omega Tau function, zeta function and tau function flying qualities criteria
[AD-A289503] p 390 N95-26844

KITADA, MAKOTO

Experimental investigation of composite channel heat pipe operation in micro-gravity environment
p 428 A95-82645

KITAJIMA, T.

Development of 70MW class superconducting generators
[BTN-94-EIX95011440854] p 429 A95-82905

KLEIN, D. E.

Convection heat transfer distributions over plates with square ribs from infrared thermography measurements
[HTN-95-20713] p 435 A95-86603

Constant flux, turbulent convection data using infrared imaging
[HTN-95-20731] p 435 A95-86621

KLEIN, VLADISLAV

Modeling of aircraft unsteady aerodynamic characteristics. Part 2: Parameters estimated from wind tunnel data
[NASA-TM-110161] p 410 N95-27839

KLINGELE, EMILE E.

Data processing and mapping in airborne radiometric surveys
[HTN-95-51587] p 442 A95-83591

KLOPPER, GOETZ H.

Computational support of the laminar flow supersonic wind tunnel, CNSFV code development, Maglev, and grid generation
[NASA-CR-197750] p 411 N95-26775

KLOTZ, STEPHEN P.

Numerical simulation of the SOFIA flow field
[NASA-CR-197757] p 436 N95-26589

KLUPFEL, T.

Airborne measurements during the European Arctic Stratospheric Ozone Experiment : Observation of OCIO
[HTN-95-00745] p 445 A95-86315

KNOPS, H. A. J.

Numerical simulation of crack growth in pressurized fuselages
[PB95-192415] p 400 N95-28636

KNUDSEN, B. M.

Airborne measurements during the European Arctic Stratospheric Ozone Experiment : Observation of OCIO
[HTN-95-00745] p 445 A95-86315

KOBAYASHI, TOMOYUKI

Research and development of thermal protection system of HOPE re-entry vehicle
p 413 A95-82358

KOFF, B. L.

Aircraft gas turbine emissions challenge
[BTN-94-EIX95011441239] p 403 A95-84196

KOKUBUN, S.

Polar Patrol Balloon system and preliminary experimental results
p 368 A95-82513

KOMURO, TOMOYUKI

Experiment on a rectangular cross section scramjet combustor. 2: Effects of fuel injector geometry
[NAL-TR-1220] p 405 N95-26600

KOUL, A. K.

The effects of surface modification on fretting fatigue in Ti alloy turbine components
[HTN-95-61145] p 404 A95-84909

KOUL, R.

Mobile domes for TACTIC telescope
p 453 A95-86113

KOURA, KATSUHIKA

Rarefied gas numerical wind tunnel: OREX and HOPE
p 427 A95-82391

KRAFT, ROBERT E.

Aircraft IR/acoustic detection evaluation. Volume 2: Development of a ground-based acoustic sensor system for the detection of subsonic jet-powered aircraft
[NASA-CR-189705-VOL-2] p 452 N95-28073

KRAL, LINDA D.

The applicability of turbulence models to aerodynamic and propulsion flowfields at McDonnell-Douglas Aerospace
p 439 N95-27886

KRANTZ, TIMOTHY L.

Vibration analysis of a split path gearbox
[NASA-TM-106875] p 438 N95-27855

KRIEG, E. J.

Ceramic composite attachments for transmission of high-torque loads
[BTN-94-EIX95011441256] p 417 A95-84213

KRISHNAKUMAR, K.

Neuro-controllers for adaptive helicopter training
[SAE PAPER 932535] p 379 A95-84557

KRUSE, SCOT

An experimental investigation of helicopter downwash and tailboom interaction at the Wichita State University 7x10 foot wind tunnel
p 375 N95-26955

KUBE, ROLAND

A higher harmonic control test in the DNW to reduce impulsive BVI noise
[HTN-95-61071] p 385 A95-83655

KUBOTA, HIROTOSHI

Hypersonic thermal protection with mass injection at angle of attack
p 414 A95-82414

KUCHAR, JAMES K.

Part-task simulator evaluations of advanced terrain displays
[SAE PAPER 932570] p 401 A95-84567

KUDOU, KENJI

Experiment on a rectangular cross section scramjet combustor. 2: Effects of fuel injector geometry
[NAL-TR-1220] p 405 N95-26600

KUJI, MAKOTO

Air truth validation of cloud albedo estimated from NOAA advanced very high resolution radiometer data
[HTN-95-A1021] p 443 A95-84526

KULLERD, SUSAN M.

Development of stitched/RTM composite primary structures
p 425 N95-28469

Test and analysis results for composite transport fuselage and wing structures
p 398 N95-28470

KUMARI, M.

Free convection past a uniform flux surface inclined at a small angle to the horizontal
[HTN-95-42213] p 430 A95-84029

KUNZ, STEVEN E.

The performance of cargo airdrop systems using g-12E parachutes: Statistical determination of minimum altitude
[AD-A291666] p 381 N95-28454

KUNZI, K.

Aircraft measurements of CLO and HCL during EASOE 1991/92
[HTN-95-00721] p 444 A95-86291

KWA, TECK-SENG

COINS: A composites information database system
p 453 N95-28465

L**LADD, JOHN A.**

The applicability of turbulence models to aerodynamic and propulsion flowfields at McDonnell-Douglas Aerospace
p 439 N95-27886

LAFON, PHILIPPE

Stochastic approach to noise modeling for free turbulent flows
[HTN-95-42321] p 371 A95-86150

LAM, C.-M. G.

Vortex methods for the computational analysis of rotor/body interaction
[HTN-95-61072] p 369 A95-83656

LAMB, J. P.

Convection heat transfer distributions over plates with square ribs from infrared thermography measurements
[HTN-95-20713] p 435 A95-86603

Constant flux, turbulent convection data using infrared imaging
[HTN-95-20731] p 435 A95-86621

LANGHALS, TAMMY

Further investigations of icing effects on an advanced high-lift multi-element airfoil
[NASA-TM-106947] p 381 N95-27762

LARSON, VICKIE L.

A review of falconry as a bird control technique with recommendations for use at the Shuttle Landing Facility, John F. Kennedy Space Center, Florida, USA
[NASA-TM-110142] p 381 N95-27859

LASH, THOMAS J.

Hardware cleanliness methodology and certification
p 419 N95-27656

LAW, G. E.

Applications of a damage tolerance analysis methodology in aircraft design and production
p 426 N95-28483

LEE, A. H. W.

Constant flux, turbulent convection data using infrared imaging
[HTN-95-20731] p 435 A95-86621

LEE, CHRISTOPHER A.

Design and testing of low sonic boom configurations and an oblique all-wing supersonic transport
[NASA-CR-197744] p 389 N95-26651

LEE, M. F.

F/A-18 IFOSTP Fatigue test airbag load determination on the vertical and horizontal tails
[DSTO-TR-0135] p 388 N95-26389

LEE, S.

Scarf joint technique with cocured and precured patches for composite repair
p 396 N95-27524

LEE, SOOGAB

Reduction of blade-vortex interaction noise through porous leading edge
[HTN-95-42324] p 371 A95-86153

LEIGH, JAMES E.

An experimental investigation of helicopter downwash and tailboom interaction at the Wichita State University 7x10 foot wind tunnel
p 375 N95-26955

LEISHMAN, J. G.

On the influence of time-varying flow velocity on unsteady aerodynamics
[HTN-95-61073] p 369 A95-83657

LEONARD, G.

Development of an aeroderivative gas turbine dry low emissions combustion system
[BTN-94-EIX95011441246] p 417 A95-84203

LEONARD, THOMAS L.

Integrated flight crew transition training for the advanced flight deck aircraft
[SAE PAPER 932599] p 380 A95-84571

LEW, THOMAS M.

Recent developments in nylon superpressure balloons
p 385 A95-82512

LEWIS, MARK

The effect of high lift to drag ratio on aerobraking
p 415 A95-85807

LI-YI, WU

An inverse design method of transonic airfoil and wing
[HTN-95-71128] p 385 A95-83489

LIBESKIND, M.

Development of composite carrythrough bulkhead
p 423 N95-28438

LIBRESCU, L.

Vibrational behavior of adaptive aircraft wing structures modelled as composite thin-walled beams
p 423 N95-28435

LINES, N. P.

Control requirements for the RB 211 low-emission combustion system
[BTN-94-EIX95011441244] p 416 A95-84201

LINHUA, WANG

Study on a scheme for the prolongation of microgravity time of balloon-borne drop capsule
p 414 A95-82515

LINNETT, I. W.

Subharmonic and quasi-periodic motions of an eccentric squeeze film damper-mounted rigid rotor
[BTN-94-EIX95011440601] p 429 A95-82982

LIPPKE, C.

GETRAN: A generic, modularly structured computer code for simulation of dynamic behavior of aero- and power generation gas turbine engines
[BTN-94-EIX95011441241] p 431 A95-84198

LIU, MENG-ZHAO

The analysis of the processing increased weight for pilot production of F-X aircraft
[HTN-95-71133] p 385 A95-83494

LORENTE, STEVEN

Application of advanced material systems to composite frame elements
p 422 N95-28432

LOBITZ, DON W.

A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines
p 439 N95-27980

LOCKHART, RONALD

Precision landing system mathematical modeling study report for Andrews Air Force Base, runway 19L, Camp Springs, MD
[AD-A289015] p 384 N95-27903

LOMBARDO, G.

Artificial intelligence for turboprop engine maintenance
[HTN-95-92313] p 404 A95-85357

LONGMIRE, ELLEN K.

Active open-loop control of particle dispersion in round jets
[HTN-95-42334] p 372 A95-86163

LONGO, J. M. A.

Compressible inviscid vortex flow of a sharp edge delta wing
[BTN-95-EIX95262694308] p 370 A95-85479

LOTTS, C. G.

Technology integration box beam failure study
p 441 N95-28468

LOUIS, STEVEN

Micro-time stress measurement device development
[AD-A289511] p 448 N95-26845

LOYD, B.

Anechoic wind tunnel study of turbulence effects on wind turbine broadband noise
p 451 N95-27992

LU, PONG-JEU

Transonic flutter suppression using active acoustic excitations
[BTN-95-EIX95262694310] p 408 A95-85481

LUI, R. K.

Experimental investigation of flow-boiling heat transfer under microgravity
p 428 A95-82642

- LYON, T. F.**
Nitrogen oxide emissions characteristics of augmented turbofan engines
[BTN-94-EIX95011441240] p 403 A95-84197

M

- MA, LIBIN**
Numerical analysis of flow field around gas rudder
p 407 A95-82333
- MADAN, RAM C.**
Test and analysis results for composite transport fuselage and wing structures p 398 N95-28470
- MADDALON, JEFFREY M.**
A study of workstation computational performance for real-time flight simulation
[NASA-TM-109184] p 449 N95-27241
- MADHUSUDAN, R. S.**
Boundary layer studies over an S-blade
[HTN-95-92261] p 434 A95-85305
- MAEKAWA, SYOZO**
A study on aerodynamic heating phenomena in three-dimensional shock wave/turbulent boundary layer interaction induced by sweptback sharp fins at supersonic flow
p 428 A95-82419
- MAESTRELLO, L.**
Interaction of jet noise with a nearby panel assembly
[BTN-95-EIX95262694295] p 434 A95-85466
Acoustic field in unsteady moving media
[NASA-CR-198162] p 438 N95-27179
Response of multi-panel assembly to noise from a jet in forward motion
[NASA-CR-198164] p 442 N95-28673
- MAIER, A.**
On aircraft repair verification of a fighter A/C integrally stiffened fuselage skin
p 394 N95-27515
- MAIER, A. E.**
Composite repair of a CF18: Vertical stabilizer leading edge
p 395 N95-27517
- MAIN, PERRY S.**
The CBT alternative for aviation training: Is it meeting the need?
[SAE PAPER 932596] p 379 A95-84568
- MALITSKY, CHRISTOPHER**
Weather And Radar Processor (WARP) Test and Evaluation Master Plan (TEMP)
[AD-A288280] p 445 N95-26453
- MALPICA, F.**
Contribution of thermal radiation to the temperature profile of ceramic composite materials
[BTN-94-EIX95011441252] p 417 A95-84209
- MANI, MORI**
The applicability of turbulence models to aerodynamic and propulsion flowfields at McDonnell-Douglas Aerospace
p 439 N95-27866
- MANKBADI, REDA R.**
Structure of supersonic jet flow and its radiated sound
[HTN-95-51645] p 431 A95-85027
- MANSUR, M. HOSSEIN**
Development and validation of a blade-element mathematical model for the AH-64A Apache helicopter
[NASA-TM-108863] p 367 N95-26710
- MANTEGAZZA, P.**
Matrix fraction approach for finite-state aerodynamic modeling
[BTN-95-EIX95262694311] p 365 A95-85482
- MARSH, D. N.**
Flex cycle combustor development and demonstration
[BTN-94-EIX95011441245] p 417 A95-84202
- MARTIN, ROBERT C., IV**
A gain scheduling optimization method using genetic algorithms
[AD-A289306] p 448 N95-26920
- MASTRODDI, F.**
Matrix fraction approach for finite-state aerodynamic modeling
[BTN-95-EIX95262694311] p 365 A95-85482
- MATSUMOTO, HIROAKI**
Rarefied gas numerical wind tunnel: OREX and HOPE
p 427 A95-82391
- MATSUMOTO, MASASHI**
Evaluation of scramjet nozzle performance
p 402 A95-82321
- MATSUMOTO, SHINICHI**
Hypersonic thermal protection with mass injection at angle of attack
p 414 A95-82414
- MATSUMOTO, SHUICHI**
Flight evaluation of GPS/DGPS sensor systems installed in NAL Do228
[NAL-TR-1230] p 382 N95-26585
- MATSUNOBU, Y.**
Development of 70MW class superconducting generators
[BTN-94-EIX95011440854] p 429 A95-82905

- MATSUSHIMA, KOICHI**
Flight evaluation of DGPS and DGPS-INS navigation systems
p 382 A95-82462
- MAVRIPLIS, DIMITRI J.**
Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils
[NASA-TP-3496] p 378 N95-28674
- MCDANIEL, J. C.**
Computational/experimental investigation of staged injection into a Mach 2 flow
[HTN-95-51646] p 432 A95-85028
- MCDANIEL, JAMES C.**
Quantitative investigation of compressible mixing: Staged transverse injection into Mach 2 flow
[HTN-95-42330] p 404 A95-86159
- MCDONACH, ALASTER**
SMART materials: Surfaces, transforms and interfaces. The commensurate engineering dimension
[AD-A289598] p 442 N95-28649
- MCKERLEAN, DONALD P.**
Benefits and limitations of composites in carrier-based aircraft
p 422 N95-28422
- MCEWEN, RON S.**
SMART materials: Surfaces, transforms and interfaces. The commensurate engineering dimension
[AD-A289598] p 442 N95-28649
- MCGARRY, FRANK**
Software process improvement in the NASA software engineering laboratory
[AD-A289912] p 450 N95-28627
- MCGREEVY, J. L.**
Interaction of jet noise with a nearby panel assembly
[BTN-95-EIX95262694295] p 434 A95-85466
Response of multi-panel assembly to noise from a jet in forward motion
[NASA-CR-198164] p 442 N95-28673
- MCINNIS, LONA A.**
Mechanism of deposit formation on fuel-wetted hot metal surfaces
[AD-A289847] p 426 N95-28621
- MCKENNA, H. E.**
Observed acoustic and aeroelastic spectral responses of a MOD-2 turbine blade to turbulence excitation
p 451 N95-27991
- MCLEAN, L. J.**
Subharmonic and quasi-periodic motions of an eccentric squeeze film damper-mounted rigid rotor
[BTN-94-EIX95011440601] p 429 A95-82982
- MCQUILLEN, JOHN B.**
Two-phase flow research using the learjet apparatus
[NASA-TM-106814] p 438 N95-27854
- MCQUINN, NOREEN**
Human factors issues in aircraft cabin design
[SAE PAPER 932527] p 386 A95-84556
- MEADOWS, KRISTINE R.**
A numerical study of fundamental shock noise mechanisms
[NASA-TM-110608] p 451 N95-27908
- MEAKIN, ROBERT L.**
Global flowfield about the V-22 Tiltrotor Aircraft
[NASA-CR-198603] p 375 N95-27248
- MEDWIN, STEVEN**
Application of advanced material systems to composite frame elements
p 422 N95-28432
- MEGIE, G.**
An overview of the EASOE campaign
[HTN-95-00702] p 443 A95-86272
Airborne lidar observation of mountain-wave-induced polar stratospheric clouds during EASOE
[HTN-95-00738] p 444 A95-86308
- MEHRKAM, P.**
Field repair materials for naval aircraft
p 394 N95-27514
- MELVIN, R. G.**
TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual
[NASA-CR-4349] p 377 N95-28230
TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document
[NASA-CR-4348] p 378 N95-28265
- MERRICK, VERNON K.**
Flightpath synthesis and HUD scaling for V/STOL terminal area operations
[NASA-TM-110348] p 383 N95-26587
- METSCHAN, S.**
Composite fuselage crown panel manufacturing technology
p 399 N95-28474
- METZKO, JOHN**
The value of simulation for training
[AD-A289174] p 411 N95-26556

- MEYER, J. P.**
Differentiating of density in compressible flow for a pressure-based approach
[HTN-95-42349] p 373 A95-86178
- MIGNERY, L. A.**
Applications of a damage tolerance analysis methodology in aircraft design and production
p 426 N95-28483
- MIKI, YOICHIRO**
An advanced scramjet propulsion concept for A 350 MG SSTO space plane
p 402 A95-82325
- MILGRAM, JUDAH H.**
Air resonance of hingeless rotor helicopters in trimmed forward flight
[HTN-95-61075] p 369 A95-83659
- MILLER, DEAN**
Further investigations of icing effects on an advanced high-lift multi-element airfoil
[NASA-TM-106947] p 381 N95-27762
- MILLER, G. E.**
Comparative performance tests on the Mod-2, 2.5-mW wind turbine with and without vortex generators
p 377 N95-27978
- MILLER, L. S.**
An exploratory application of neural networks for airfoil design
p 448 N95-26943
- MILLER, R. D.**
Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system
p 440 N95-27983
- MINECK, RAYMOND E.**
Study of potential aerodynamic benefits from spanwise blowing at wingtip
[NASA-TP-3515] p 378 N95-28669
- MINENO, HITOSHI**
Flight evaluation of GPS/DGPS sensor systems installed in NAL Do228
[NAL-TR-1230] p 382 N95-26585
- MINGDE, ZHOU**
Plate manipulators
[AD-A289601] p 374 N95-26719
- MINGUET, PIERRE**
Application of advanced material systems to composite frame elements
p 422 N95-28432
- MIRANDY, L.**
Aeroelastic stability of wind turbine blade/aileron systems
p 377 N95-27981
Calculation of design load for the MOD-SA 7.3 mW wind turbine system
p 440 N95-27982
- MITANI, TOHRU**
Evaluation of scramjet nozzle performance
p 402 A95-82321
- MITCHELL, C. M.**
Operator modeling in commercial aviation: Cognitive models, intelligent displays, and pilot's assistants
[NASA-CR-198609] p 401 N95-28203
- MIYAJIMA, HIROSHI**
Design features of the NAL ramjet engine test facility
p 410 A95-82319
- MIYANO, TOMOYUKI**
Flight evaluation of DGPS and DGPS-INS navigation systems
p 382 A95-82462
- MIZOBUCHI, YASUHIRO**
Studies on gain performance of a combustion driven CO₂ gas dynamic laser
p 428 A95-82679
- MO, J. D.**
Numerical investigation of cylinder wake flow with a rear stagnation jet
[HTN-95-51669] p 433 A95-85051
- MOLVIK, GREGORY A.**
Development of an upwind, finite-volume code with finite-rate chemistry
[NASA-CR-197747] p 374 N95-26760
- MONGIA, H.**
Combustion system CFD modeling at GE Aircraft Engines
p 439 N95-27889
- MONTECALVO, ANTHONY J.**
Integrated mission precision attack cockpit technology (IMPACT). Phase 1: Identifying technologies for air-to-ground fighter integration
[AD-A289562] p 389 N95-26684
- MONTGOMERY, KENT R.**
Life cycle costs of alternatives for F-16 printed circuit board diagnosis equipment
[AD-A288744] p 401 N95-28586
- MOORE, G. V.**
Determining GPS average performance metrics
p 383 N95-27791
- MOORE, KEVIN A.**
An experimental investigation of helicopter downwash and tailboom interaction at the Wichita State University 7x10 foot wind tunnel
p 375 N95-26955

O

MOORE, M.

MOORE, M.

The short range attack missile/light weight
exo-atmospheric projectile (SRAM/LEAP) missile tests
program
[HTN-95-81498] p 386 A95-85212

MOORE, SALLY

Human factors issues in aircraft cabin design
[SAE PAPER 932527] p 386 A95-84556

MORAN, TOM

Maintenance programs
[HTN-95-92310] p 365 A95-85354

MORINO, L.

Matrix traction approach for finite-state aerodynamic
modeling
[BTN-95-EIX95262694311] p 365 A95-85482

MORINO, YOSHIKI

R & D on HOPE structure p 413 A95-82355
Research and development of thermal protection system
of HOPE re-entry vehicle p 413 A95-82358

MORL, P.

Two dimensional stratospheric aerosol distributions
during EASOE
[HTN-95-00726] p 444 A95-86296

MORRIS, PHILIP J.

Supersonic coaxial jet noise predictions
[NASA-TM-106917] p 451 N95-26801

MORTON, P. G.

The dynamic nature of rotor thermal bending due to
unsteady lubricant shearing within a bearing
[HTN-95-42091] p 430 A95-83857

MOTALLEBI, F.

A review of the hot-wire technique in 2-D compressible
flow
[HTN-95-61157] p 373 A95-86256

MOTYLEWSKI, JERZY

Photoacoustic chambers for studying solids and gases:
Theory and practical examples
[IFTR-39/1994] p 412 N95-26837

MURAKAMI, ATSUO

Experiment on a rectangular cross section scramjet
combustor. 2: Effects of fuel injector geometry
[NAL-TR-1220] p 405 N95-26600

MURAKAMI, ATSUSHI

R & D on HOPE structure p 413 A95-82355

MURAKAMI, MASAOKI

Experimental investigation of composite channel heat
pipe operation in micro-gravity environment
p 428 A95-82645

MURATA, MASAOKI

Flight evaluation of GPS/DGPS sensor systems installed
in NAL Do228
[NAL-TR-1230] p 382 N95-26585

MURMAN, SCOTT M.

Numerical simulation of the flow about the F-18 HARV
at high angle of attack
[NASA-CR-197755] p 374 N95-26735

MURPHY, D.

Non-linear analysis provides new insights into impact
damage of composite structures
[HTN-95-42368] p 418 A95-86197

MURRAY, W. E.

Evaluation of all-electric secondary power for transport
aircraft
[NASA-CR-189077] p 441 N95-27999

MURTHY, G. S. K.

Mobile domes for TACTIC telescope
p 453 A95-86113

MURTHY, P. L. N.

Analysis of aircraft engine blade subject to ice impact
p 407 N95-28277

MURTHY, S. N. B.

WINCLR: A computer code for heat transfer and
clearance calculation in a compressor
[NASA-CR-195436] p 366 N95-26363

MUSTER, DOUGLAS

Condition monitoring and diagnostics
[HTN-95-92312] p 387 A95-85356

MYOSE, ROY Y.

The near-wake flow behavior of an oscillating airfoil with
modified trailing edge p 375 N95-26953

N

NAGATOMO, MAKOTO

Atmospheric reentry flight test of winged space
vehicle p 414 A95-82483

NAKABAYASHI, Y.

Development of 70MW class superconducting
generators
[BTN-94-EIX95011440854] p 429 A95-82905

NAKAJIMA, TAKASHI

The aerodynamic characteristics of cup-like body in
supersonic flow p 427 A95-82407

NAKAO, SHIGEHIDE

A study on aerodynamic heating phenomena in
three-dimensional shock wave/turbulent boundary layer
interaction induced by sweptback sharp fins at supersonic
flow p 428 A95-82419

NAKAYASU, HIDEHIKO

Experimental investigation of static and dynamic ground
effect on HOPE ALFLEX vehicle
[NAL-TR-1236] p 388 N95-26525

NARUO, YOSHIHIRO

Test results on air turbo ramjet engine for a future space
plane p 402 A95-82327

NATH, G.

Free convection past a uniform flux surface inclined at
a small angle to the horizontal
[HTN-95-42213] p 430 A95-84029

NATHMAN, JAMES K.

Precision requirement for potential-based panel
methods
[HTN-95-51666] p 433 A95-85048

NEALY, JOHN E.

Radiation safety aspects of commercial high-speed flight
transportation
[NASA-TP-3524] p 453 N95-26427

NELSON, T. E.

Compressible Navier-Stokes computations of
multielement airfoil flows using multiblock grids
[HTN-95-42327] p 371 A95-86156

NERI, LARRY

Analysis of composite structures with delaminations
under combined bending and compression
p 422 N95-28429

NERI, LAWRENCE M.

Ninth DOD/NASA/FAA Conference on Fibrous
Composites in Structural Design, volume 3
[NASA-CR-198718] p 420 N95-28266

Ninth DOD/NASA/FAA Conference on Fibrous
Composites in Structural Design, volume 1
[NASA-CR-198723] p 421 N95-28420

Ninth DOD/NASA/FAA Conference on Fibrous
Composites in Structural Design, volume 2
[NASA-CR-198722] p 424 N95-28462

NESVIZSKY, G.

Prediction of fatigue crack growth under constant
amplitude and random loading using specimens with
multiple cracks
[AD-A291614] p 397 N95-28409

NETT, H.

Aircraft measurements of CLO and HCL during EASOE
1991/92
[HTN-95-00721] p 444 A95-86291

NEUMANN, ERIC S.

Two-phase flow research using the learjet apparatus
[NASA-TM-106814] p 438 N95-27854

NEWMAN, JAMES C.

Dynamic unstructured method for flows past multiple
objects in relative motion
[BTN-95-EIX95262694303] p 435 A95-85474

NEWMAN, LAURI KRAFT

Reentry analysis for low Earth orbiting spacecraft
p 415 A95-85774

NIESL, GEORG

A higher harmonic control test in the DNW to reduce
impulsive BVI noise
[HTN-95-61071] p 385 A95-83655

NIINO, MASAYUKI

A conceptual design of hypersonic research vehicle with
subscale scramjet engine p 384 A95-82482

NIIOKA, TAKASHI

Ignition analysis of hydrogen/air mixture in supersonic
mixing layer p 416 A95-82301

NISHIDA, MICHIO

VSL analysis of hypersonic flows around a reentry
vehicle with equilibrium air chemistry p 413 A95-82400

NISHIMURA, J.

Polar Patrol Balloon system and preliminary
experimental results p 368 A95-82513

NODERER, KEITH D.

Modeling of aircraft unsteady aerodynamic
characteristics. Part 2: Parameters estimated from wind
tunnel data
[NASA-TM-110161] p 410 N95-27839

NORMAN, R. MICHAEL

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aerospace: SAE Aerotech '93, Costa Mesa, CA, Sep.
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[SAE SP-992] p 417 A95-84553

NORTHAM, G. B.

Computational/experimental investigation of staged
injection into a Mach 2 flow
[HTN-95-51646] p 432 A95-85028

NYQUIST, D. P.

Time-domain imaging of airborne targets using
ultra-wideband or short-pulse radar
[BTN-95-EIX95242673673] p 450 A95-82251

O'BRIEN, W. F.

Artificial neural networks for predicting nonlinear
dynamic helicopter loads
[HTN-95-51678] p 404 A95-85060

O'NEILL, A.

An overview of the EASOE campaign
[HTN-95-00702] p 443 A95-86272

OBAYASHI, SHIGERU

Practical formulation of a positively conservative
scheme
[HTN-95-51668] p 433 A95-85050

OCKIER, C. J.

An investigation of the effects of pitch-roll (de)coupling
on helicopter handling qualities
[NASA-TM-110349] p 409 N95-26773

ODA, KENSHI

Development and flight results of fiber reinforced
balloon p 384 A95-82511

OERTEL, HERBERT

Reentry technology experiment on the first mission of
reentry capsule 'EXPRESS' p 414 A95-82499

OGURA, EIJI

Studies on gain performance of a combustion driven
CO₂ gas dynamic laser p 428 A95-82679

OGUSHI, T.

Experimental investigation of flow-boiling heat transfer
under microgravity p 428 A95-82642

OGUSHI, TETSUROU

Experimental investigation of composite channel heat
pipe operation in micro-gravity environment
p 428 A95-82645

OHNUKI, TAKESHI

Experimental investigation of static and dynamic ground
effect on HOPE ALFLEX vehicle
[NAL-TR-1236] p 388 N95-26525

OHOTA, S.

Polar Patrol Balloon system and preliminary
experimental results p 368 A95-82513

OHSHIMA, S.

Development of 70MW class superconducting
generators
[BTN-94-EIX95011440854] p 429 A95-82905

OHYAMA, KENICHI

Numerical simulation of unsteady aerodynamic heating
induced by shock reflections p 428 A95-82418

OLBERT, C.

Mapping of forest fire damages using imaging
spectroscopy p 442 A95-83627

OLSON, RICHARD J.

Development of repair processes and sources for
C/KC-135 aircraft windows/windshields
[AD-A288348] p 367 N95-26629

ONO, F.

Experiment of rocket-ram annular combustor
p 412 A95-82324

ONO, TAKATSUGU

Flight evaluation of DGPS and DGPS-INS navigation
systems p 382 A95-82462

Flight evaluation of GPS/DGPS sensor systems installed
in NAL Do228
[NAL-TR-1230] p 382 N95-26585

ONOE, KEN-ICHI

Life evaluation of a low power arcjet thruster
p 403 A95-82337

ORLANSKY, JESSE

The value of simulation for training
[AD-A289174] p 411 N95-26556

ORR, HORACE A.

Integrated mission precision attack cockpit technology
(IMPACT). Phase 1: Identifying technologies for
air-to-ground fighter integration
[AD-A289562] p 389 N95-26684

OSHRAT, J.

Prediction of fatigue crack growth under constant
amplitude and random loading using specimens with
multiple cracks
[AD-A291614] p 397 N95-28409

OSTOWARI, CYRUS

Horizontal axis wind turbine post stall airfoil
characteristics synthesization p 376 N95-27974

OTOOLE, BRENDAN J.

The effect of material heterogeneity in curved composite
beams for use in aircraft structures p 422 N95-28426

OWENS, S. D.

Applications of a damage tolerance analysis
methodology in aircraft design and production
p 426 N95-28483

P

PAGE, GERALD

Software process improvement in the NASA software engineering laboratory
[AD-A289912] p 450 N95-28627

PAGEAU, STEPHANE S.

Shear buckling response of tailored composite plates
[HTN-95-51680] p 418 A95-85062

PAJERSKI, ROSE

Software process improvement in the NASA software engineering laboratory
[AD-A289912] p 450 N95-28627

PAN, DARTZI

Transonic flutter suppression using active acoustic excitations
[BTN-95-EIX95262694310] p 408 A95-85481

PAN, RUO-GANG

The analysis of the processing increased weight for pilot production of F-X aircraft
[HTN-95-71133] p 385 A95-83494

PANCRAZ, DAVID J.

The large radius track centrifuge concept as an acceleration research and simulation device
p 379 A95-84560

PAREKH, D. E.

Mixing enhancement by and noise characteristics of streamwise vortices in an air jet
[HTN-95-42322] p 371 A95-86151

PATNAIK, P. C.

The effects of surface modification on fretting fatigue in Ti alloy turbine components
[HTN-95-61145] p 404 A95-84909

PAUL, P. H.

A model for temperature-dependent collisional quenching of OH A(sup 2) Sigma(sup +)
[HTN-95-42308] p 450 A95-85002

PAUSDER, H. J.

An investigation of the effects of pitch-roll (de)coupling on helicopter handling qualities
[NASA-TM-110349] p 409 N95-26773

PAWLKOWSKI, ELLEN M.

Surviving the peace. Lessons learned from the aircraft industry in the 1920s and 1930s
[AD-A288284] p 366 N95-26455

PAXSON, DANIEL E.

Optimization of wave rotors for use as gas turbine engine topping cycles
[NASA-TM-106951] p 406 N95-27860

PERNER, D.

Airborne measurements during the European Arctic Stratospheric Ozone Experiment : Observation of OClO
[HTN-95-00745] p 445 A95-86315

PEROS, VASILIOS

Application of fiber-reinforced bismaleimide materials to aircraft nacelle structures
p 397 N95-28278

PETERS, DAVID A.

Fast Floquet theory and trim for multi-bladed rotorcraft
[HTN-95-61078] p 370 A95-83662

PETRY, HERIBERT

Evolution of the concentrations of trace species in an aircraft plume: Trajectory study
[HTN-95-A1044] p 443 A95-84549

PFEIFFER, KARL DURANT

A numerical model to predict the fate of jettisoned aviation fuel
[AD-A289336] p 419 N95-26842

PFEILSTICKER, K.

Airborne measurements during the Arctic stratospheric experiment: Observation of O3 and NO2
[HTN-95-00748] p 445 A95-86318

PHILLIPS, SCOTT N.

A quantitative feedback theory FCS design for the subsonic envelope of the VISTA F-16 including configuration variation
[AD-A289221] p 409 N95-26958

PIPKINS, D. S.

A FEAM based methodology for analyzing composite patch repairs of metallic structures
p 394 N95-27511

PISOWISZCZ, V. L.

Stationary premixed flames in spherical and cylindrical geometries
[HTN-95-42336] p 418 A95-86165

PLATT, U.

Airborne measurements during the Arctic stratospheric experiment: Observation of O3 and NO2
[HTN-95-00748] p 445 A95-86318

PLENTOVICH, E. B.

Measurements of store forces and moments and cavity pressures for a generic store in and near a box cavity at subsonic and transonic speeds
[NASA-TM-4611] p 378 N95-28241

POE, C. C., JR.

Tension fracture of laminates for transport fuselage. Part 1: Material screening
p 398 N95-28471

POOLE, P.

Adhesively bonded composite patch repair of cracked aluminum alloy structures
p 393 N95-27507

POP, I.

Free convection past a uniform flux surface inclined at a small angle to the horizontal
[HTN-95-42213] p 430 A95-84029

POTAPOV, VADIM D.

Stability of viscoelastic plate in supersonic flow under random loading
[BTN-95-EIX95262694312] p 435 A95-85483

POVINELLI, LOUIS A.

Structure of supersonic jet flow and its radiated sound
[HTN-95-51645] p 431 A95-85027

PRAKASH, CHANDER

A summary of computational experience at GE Aircraft Engines for complex turbulent flows in gas turbines
p 439 N95-27885

PRINTY, MATTHEW

Weather And Radar Processor (WARP) Test and Evaluation Master Plan (TEMP)
[AD-A288280] p 445 N95-26453

PRINZO, O. V.

Development of a coding form for approach control/pilot voice communications
[DOT/FAA/AM-95/15] p 384 N95-28540

PRZEKAS, A. J.

Numerical analysis of intra-cavity and power-stream flow interaction in multiple gas-turbine disk-cavities
[NASA-TM-106886] p 407 N95-28344

PRZEKAS, ANDRZEJ J.

Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics
[NASA-TM-106685] p 416 N95-27434

PURCELL, RICHARD G.

Replicator for characterization of cirrus and polar stratospheric cloud particles
[NASA-CR-197785] p 445 N95-26669

PURI, I. K.

Mobile domes for TACTIC telescope
p 453 A95-86113

PYLE, J. A.

An overview of the EASOE campaign
[HTN-95-00702] p 443 A95-86272

PYNE, TONY

The legal status and liability of the copilot, part 2
[HTN-95-A0578] p 452 A95-83158

Q

QUACKENBUSH, T. R.

Vortex methods for the computational analysis of rotor/body interaction
[HTN-95-01072] p 369 A95-83656

QUINLIAN, J. T.

NASA-ACEE/Boeing 737 graphite-epoxy horizontal stabilizer service
p 400 N95-28489

QUINN, W. R.

Development of a large-aspect-ratio rectangular turbulent free jet
[HTN-95-42333] p 372 A95-86162

R

RADDIN, JAMES H., JR.

The large radius track centrifuge concept as an acceleration research and simulation device
p 379 A95-84560

RADERMACHER, R.

Second-law analysis of vapor compression heat pumps with solution circuit
[BTN-94-EIX95011441236] p 431 A95-84193

RADTKE, T. C.

Scarf repairs to graphite/epoxy components
p 396 N95-27523

RAIZENNE, M. D.

Bonded composite repair of thin metallic materials: Variable load amplitude and temperature cycling effects
p 393 N95-27509

RAMAMURTI, SITA

Variational principles for ascent shapes of large scientific balloons
[BTN-95-EIX95262694320] p 387 A95-85491

RAMAN, GANESH

Visualization of the multiple supersonic jet oscillations by swept focused strobed schlieren technique
p 367 N95-26952

RAND, JAMES L.

Recent developments in nylon superpressure balloons
p 385 A95-82512

RANDLE, SCOTT

An experimental investigation of helicopter downwash and tailboom interaction at the Wichita State University 7x10 foot wind tunnel
p 375 N95-26955

RANGWALLA, AKIL A.

Turbomachinery design and tonal acoustics computations
[NASA-CR-197749] p 406 N95-26777

RASHIDI, MAJID

Vibration analysis of a split path gearbox
[NASA-TM-106875] p 438 N95-27855

RASTOGI, NAVEEN

Load transfer in the stiffener-to-skin joints of a pressurized fuselage
[NASA-CR-198610] p 439 N95-27865

RATHAKRISHNAN, E.

Flow past a symmetric wedge with forward splitter plate
p 427 A95-82406

RAWLS, J. RICHARD

Hardware cleanliness methodology and certification
p 419 N95-27656

REDDEN, MARK C.

Integrated mission precision attack cockpit technology (IMPACT). Phase 1: Identifying technologies for air-to-ground fighter integration
[AD-A289562] p 389 N95-26684

REDDY, E. S.

Analysis of aircraft engine blade subject to ice impact
p 407 N95-28277

REED, HELEN L.

Transition correlations in three-dimensional boundary layers
[HTN-95-51648] p 432 A95-85030

REEVES, J. M.

An overview of millimeter-wave spectroscopic measurements of chlorine monoxide at Thule, Greenland, February-March, 1992: Vertical profiles, diurnal variation, and longer-term trends
[HTN-95-00722] p 444 A95-86292

REEVES, JOHN

Balanced on air aircraft
[AD-D017251] p 389 N95-26537

REGINATTO, MARCEL

Radiation safety aspects of commercial high-speed flight transportation
[NASA-TP-3524] p 453 N95-26427

REHFELD, LAWRENCE W.

Unique considerations in the design and experimental evaluation of tailored wings with elastically produced chordwise camber
p 423 N95-28436

RENGER, W.

Two dimensional stratospheric aerosol distributions during EASOE
[HTN-95-00726] p 444 A95-86296

RENIERI, GARY D.

Analysis techniques for the prediction of springback in formed and bonded composite components
p 421 N95-28289

RENIERI, M. P.

ACT/ICAPS: Thermoplastic composite activities
p 421 N95-28274

REYNOLDS, GREGORY A.

Demonstration study of hierarchical control of fluid-dynamic phenomena
[AD-A289341] p 437 N95-26751

REZY, BERNIE J.

Propulsion system assessment for very high UAV under ERAT
[NASA-CR-195469] p 406 N95-27866

RHOADS, GREGORY L.

Partial discharge testing of high voltage wiring harness for airborne displays
[AD-A289150] p 401 N95-27003

RILEY, EDWARD W.

Intelligent flight trainer for initial rotary wing training
[SAE PAPER 932536] p 386 A95-84558

RINEK, LARRY M.

Charles Norvin Rinek; an early American pioneer in advanced aviation engines
[SAE PAPER 930485] p 386 A95-84554

RINOIE, KENICHI

Experimental investigation of static and dynamic ground effect on HOPE ALFLEX vehicle
[NAL-TR-1236] p 388 N95-26525

RISKALLA, M. G.

Probabilistic design of advanced composite structure
p 424 N95-28443

RIVERA, JOSE A., JR.

Flutter clearance flight tests of an OV-10A airplane modified for wake vortex flight experiments
[NASA-TM-109168] p 366 N95-26381

ROCHE, NIGEL R.

Automatic riveting cell for commercial aircraft floor grid assembly
[HTN-95-92309] p 365 A95-85353

ROEBROEKS, G. H. J. J.

Fibre-Metal laminates
p 387 A95-85895

- ROGERS, C. A.**
Vibrational behavior of adaptive aircraft wing structures modelled as composite thin-walled beams
p 423 N95-28435
- ROGERS, C. B.**
Mixing enhancement by and noise characteristics of streamwise vortices in an air jet
[HTN-95-42322] p 371 A95-86151
- ROHRER, RANDI**
Human factors issues in aircraft cabin design
[SAE PAPER 932527] p 386 A95-84556
- ROKNAIDIN, FARZAM**
Predicting stall and post-stall behavior of airfoils at low mach numbers
[BTN-95-EIX95262694297] p 365 A95-85468
- ROKUTANDA, ITARU**
Test results on air turbo ramjet engine for a future space plane
p 402 A95-82327
- ROLEK, EVAN P.**
Integrated mission precision attack cockpit technology (IMPACT). Phase 1: Identifying technologies for air-to-ground fighter integration
[AD-A289562] p 389 N95-26684
- RONNEY, P. D.**
Stationary premixed flames in spherical and cylindrical geometries
[HTN-95-42336] p 418 A95-86165
- ROSE, WILLIAM C.**
Application of CFD to the analysis and design of high-speed inlets
[NASA-CR-198574] p 438 N95-27240
- ROSENZWEIG, E. L.**
Navy composite maintenance and repair experience
p 424 N95-28446
- ROSKAM, JAN**
An easy way to analyze longitudinal and lateral-directional trim problems with AEO or OEI
p 409 N95-26949
- ROSNER, DANIEL E.**
Transport phenomena and interfacial kinetics in multiphase combustion systems
[AD-A288297] p 418 N95-26417
- ROSS, BRIAN P.**
Reentry analysis for low Earth orbiting spacecraft
p 415 A95-85774
- ROSS, DANIEL C.**
Hybrid finite element-modal analysis of jet engine inlet scattering
[BTN-95-EIX95242673665] p 427 A95-82259
- ROSS, J. E.**
Time-domain imaging of airborne targets using ultra-wideband or short-pulse radar
[BTN-95-EIX95242673673] p 450 A95-82251
- ROTH, RICHARD**
The potential for CMCs to replace superalloys in engine exhaust ducts
[HTN-95-42298] p 418 A95-84992
- ROTHBERG, S. J.**
Vibration measurements on rotating machinery using laser Doppler velocimetry
[BTN-94-EIX95011440597] p 429 A95-82986
- ROTHER, S. L.**
Air traffic operational inventory CY 1994
[AD-A288281] p 382 N95-26454
- ROTHWELL, E. J.**
Time-domain imaging of airborne targets using ultra-wideband or short-pulse radar
[BTN-95-EIX95242673673] p 450 A95-82251
- ROUNDY, L. M.**
ACT/ICAPS: Thermoplastic composite activities
p 421 N95-28274
- ROUSE, MARSHALL**
Damage tolerance of a geodesically stiffened advanced composite structural concept for aircraft structural applications
p 399 N95-28487
- ROWE, SEAN P.**
A review of falconry as a bird control technique with recommendations for use at the Shuttle Landing Facility, John F. Kennedy Space Center, Florida, USA
[NASA-TM-110142] p 381 N95-27859
- RUAN, YING-ZHENG**
Analysis of backscattering from wing and fuselage joints
[HTN-95-71134] p 430 A95-83495
- RUFFY, ALAN E.**
Parallel block implicit integration technique for trajectory parallelism
[AD-A288961] p 450 N95-28335
- RUSHTON, ELLIOTT**
Precision landing system mathematical modeling study report for Andrews Air Force Base, runway 19L, Camp Springs, MD
[AD-A289015] p 384 N95-27903
- RUSSELL, A. J.**
Composite repair issues on the CF-18 aircraft
p 395 N95-27518

- RUTH, JOHN**
Application of fiber-reinforced bismaleimide materials to aircraft nacelle structures
p 397 N95-28278
- RYAN, JAMES S.**
CFD research, parallel computation and aerodynamic optimization
[NASA-CR-197748] p 373 N95-26649
- RYBACH, LADISLAUS**
Data processing and mapping in airborne radiometric surveys
[HTN-95-51587] p 442 A95-83591

S

- SACKS, HOWARD**
Design of a high altitude long endurance aircraft with manufacturing considerations
p 391 N95-26947
- SAGISAKA, MASAKAZU**
Experimental investigation of static and dynamic ground effect on HOPE ALFLEX vehicle
[NAL-TR-1236] p 388 N95-26525
- SAITO, TOSHIHITO**
Experiment and analysis on heat transfer of a scramjet leading edge model
p 403 A95-82420
- SAKAMOTO, H.**
Experiment of rocket-ram annular combustor
p 412 A95-82324
- SAKAMURA, YOSHITAKA**
VSL analysis of hypersonic flows around a reentry vehicle with equilibrium air chemistry
p 413 A95-82400
- SAKURANAKA, NOBORU**
Experiment and analysis on heat transfer of a scramjet leading edge model
p 403 A95-82420
- SALTER, CHARLES A.**
The effects of UH-1 experience on UH-60 simulator performance: A preliminary study
[AD-A289457] p 391 N95-26993
- SAMANT, S. S.**
TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual
[NASA-CR-4349] p 377 N95-28230
- SAMANT, S. S.**
TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document
[NASA-CR-4348] p 378 N95-28265
- SAMS, E. C.**
A laboratory scale supersonic combustive flow system
[DE95-006347] p 420 N95-27851
- SANTARE, MICHAEL H.**
The effect of material heterogeneity in curved composite beams for use in aircraft structures
p 422 N95-28426
- SASAKI, M.**
Experiment of rocket-ram annular combustor
p 412 A95-82324
- SASOH, AKIHIRO**
An experimental study on radiation from strong shock layer
p 368 A95-82421
- SATO, K.**
Experiment of rocket-ram annular combustor
p 412 A95-82324
- SATO, SHIGERU**
Evaluation of scramjet nozzle performance
p 402 A95-82321
- SATO, YOICHI**
Research and development of thermal protection system of HOPE re-entry vehicle
p 413 A95-82358
- SAUNDERS, P.**
Digital systems validation. Chapter 20 Artificial Intelligence with applications for aircraft. Handbook, volume 2
[AD-A288492] p 448 N95-26638
- SAWAZAKI, H.**
Development of 70MW class superconducting generators
[BTN-94-EIX95011440854] p 429 A95-82905
- SAWHNEY, S.**
Neuro-controllers for adaptive helicopter training
[SAE PAPER 932535] p 379 A95-84557
- SCHAALE, M.**
Mapping of forest fire damages using imaging spectroscopy
p 442 A95-83627
- SCHADOW, KLAUS C.**
Suppressor of oscillations in airframe cavities
[AD-D017265] p 388 N95-26507
- SCHANZENBACH, GEORGE P.**
Control system design for the MOD-5A 7.3 mW wind turbine generator
p 440 N95-27985
- SCHUYVE, J.**
Fatigue of aircraft materials and structures
p 387 A95-85894

- SCHINDLER, R.**
External patch repair of CFRP/honeycomb sandwich
p 395 N95-27522
- SCHMIDT, LOUIS V.**
Wind-tunnel tests of an inclined cylinder having helical grooves
[BTN-95-EIX95262694306] p 411 A95-85477
- SCHNEIDER, STEVEN P.**
Quiet-flow Ludwig tube for high-speed transition research
[BTN-95-EIX95262694309] p 370 A95-85480
- SCHOBEIRI, M. T.**
GETRAN: A generic, modularly structured computer code for simulation of dynamic behavior of aero- and power generation gas turbine engines
[BTN-94-EIX95011441241] p 431 A95-84198
- SCHULTZ, KLAUS-J.**
A higher harmonic control test in the DNW to reduce impulsive BVI noise
[HTN-95-61071] p 385 A95-83655
- SCHWARZ, GEORG F.**
Data processing and mapping in airborne radiometric surveys
[HTN-95-51587] p 442 A95-83591
- SCHWEICKART, DANIEL**
Partial discharge testing of high voltage wiring harness for airborne displays
[AD-A289150] p 401 N95-27003
- SCOTT, R. F.**
Scar joint technique with cocured and precured patches for composite repair
p 396 N95-27524
- SCOTT, WILLIAM B.**
Cuts endanger airborne research
[HTN-95-20602] p 443 A95-84783
- SEELY, LOREN G.**
Recent developments in nylon superpressure balloons
p 385 A95-82512
- SEGAWA, SHINYA**
Development and flight results of fiber reinforced balloon
p 384 A95-82511
- SEMPLE, C. A.**
Assessment of cost and training effectiveness for a candidate training system using the Comparison-Based Prediction model
[SAE PAPER 932598] p 379 A95-84570
- SENSENEY, MICHAEL B.**
Performance characterization of a highly-offset diffuser with and without blowing vortex generator jets
[AD-A289334] p 375 N95-26901
- SETO, S. P.**
Nitrogen oxide emissions characteristics of augmented turbofan engines
[BTN-94-EIX95011441240] p 403 A95-84197
- SEWALL, WILLIAM G.**
Airfoil modification effects on subsonic and transonic pressure distributions and performance for the EA-6B airplane
[NASA-TP-3516] p 373 N95-26382
- SHABBI, AAMIR**
Industry-Wide Workshop on Computational Turbulence Modeling
[NASA-CP-10165] p 439 N95-27882
- SHAH, BHARAT M.**
Advanced textile applications for primary aircraft structures
p 399 N95-28476
- SHAPIRO, DIANE C.**
Education, training, and human engineering in aerospace; SAE Aerotech '93, Costa Mesa, CA, Sep. 27-30, 1993
[SAE SP-992] p 417 A95-84553
- SHAW, ROBERT J.**
The high speed civil transport and NASA's High Speed Research (HSR) program
p 390 N95-26945
- SHELDON, DAVID**
Further investigations of icing effects on an advanced high-lift multi-element airfoil
[NASA-TM-106947] p 381 N95-27762
- SHENGXI, SHI**
Plate manipulators
[AD-A289601] p 374 N95-26719
- SHEPHERD, K. P.**
Measurement and prediction of broadband noise from large horizontal axis wind turbine generators
p 451 N95-27990
- SHERWOOD, TOM**
Preliminary results and research capabilities of a new jet facility at the University of Kansas
p 412 N95-26951
- SHIAO, MICHAEL C.**
Probabilistic evaluation of fuselage-type composite structures
p 398 N95-28444
- SHIFRIN, CAROLE A.**
European firms team on supersonic studies
[HTN-95-42215] p 386 A95-84031

- SHIGEMI, MASASHI**
Experimental investigation of static and dynamic ground effect on HOPE ALFLEX vehicle
[NAL-TR-1236] p 388 N95-26525
- SHIMOMURA, K.**
Study on the turbine vane and blade for a 1500 C class industrial gas turbine
[BTN-94-EIX95011441254] p 431 A95-84211
- SHIN, JAIWON**
Further investigations of icing effects on an advanced high-lift multi-element airfoil
[NASA-TM-106947] p 381 N95-27762
- SHINDELL, D. T.**
An overview of millimeter-wave spectroscopic measurements of chlorine monoxide at Thule, Greenland, February-March, 1992: Vertical profiles, diurnal variation, and longer-term trends
[HTN-95-00722] p 444 A95-86292
- SHINGU, HIROKIMI**
Flight evaluation of DGPS and DGPS-INS navigation systems
p 382 A95-82462
- SHINN, JUDY L.**
Radiation safety aspects of commercial high-speed flight transportation
[NASA-TP-3524] p 453 N95-26427
- SHIPLEY, S. A.**
Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system
p 440 N95-27983
- SHIROUZI, MASAO**
A concept of a hypersonic flight experiment of a winged vehicle
p 414 A95-82477
- SHORTS, VINCENT F.**
A mathematical analysis of the Janus combat simulation weather effects models and sensitivity analysis of sky-to-ground brightness ratio on target detection
[AD-A289629] p 446 N95-26858
- SHUART, MARK J.**
Composite fuselage shell structures research at NASA Langley Research Center
p 425 N95-28466
Technology integration box beam failure study
p 441 N95-28468
- SHUCHENG, ZHANG**
Numerical investigation to S-inlet flows (Numerical simulation study of S-inlet flows)
[AD-A289590] p 374 N95-26713
- SHUKLA, JAY G.**
Advanced textile applications for primary aircraft structures
p 399 N95-28476
- SHYU, RONG-NAN**
High angle-of-attack airfoil performance improvement by internal acoustic excitation
[HTN-95-42347] p 372 A95-86176
- SIDDIQI, SHAHID**
COINS: A composites information database system
p 453 N95-28465
- SIH, G. C.**
Evaluation of patch effectiveness in repairing aircraft components
p 394 N95-27513
- SILVA, K.**
C-130 Advanced Technology Center wing box conceptual design/cost study
p 423 N95-28437
- SIMPSON, D. L.**
Bonded composite repair of thin metallic materials: Variable load amplitude and temperature cycling effects
p 393 N95-27509
- SINGH, KAMAKHYA P.**
Dynamic unstructured method for flows past multiple objects in relative motion
[BTN-95-EIX95262694303] p 435 A95-85474
- SKINNER, ROGER**
Maintenance programs
[HTN-95-92310] p 365 A95-85354
- SMITH, J.**
Design and structural validation of CF116 upper wing skin boron doubler
p 393 N95-27510
- SMITH, J. R.**
A hybrid vehicle evaluation code and its application to vehicle design. Revision 1
[DE95-008053] p 441 N95-28029
A hybrid vehicle evaluation code and its application to vehicle design, revision 2
[DE95-008060] p 441 N95-28139
- SMITH, ROBERT A.**
Suppressor of oscillations in airframe cavities
[AD-D017265] p 388 N95-26507
- SMITH, RONALD L.**
The effects of UH-1 experience on UH-60 simulator performance: A preliminary study
[AD-A289457] p 391 N95-26993
- SNYDER, M. H.**
Comparative wind tunnel tests of NACA 23024 airfoils with several aileron and spoiler configurations
p 376 N95-27976
- SODERQUIST, JOSEPH R.**
Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 3
[NASA-CR-198718] p 420 N95-28266
Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 1
[NASA-CR-198723] p 421 N95-28420
Ninth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, volume 2
[NASA-CR-198722] p 424 N95-28462
- SOMERS, D. M.**
Wind-tunnel test of the S814 thick root airfoil
[DE95-000268] p 376 N95-27541
- SONG, O.**
Vibrational behavior of adaptive aircraft wing structures modelled as composite thin-walled beams
p 423 N95-28435
- SPARACO, PIERRE**
European firms team on supersonic studies
[HTN-95-42215] p 386 A95-84031
- SPARKS, ANDREW G.**
Robust longitudinal axis flight control for an aircraft with thrust vectoring
[BTN-95-EIX95122538875] p 408 A95-83000
- SPARKS, R. J.**
Assessment of cost and training effectiveness for a candidate training system using the Comparison-Based Prediction model
[SAE PAPER 932598] p 379 A95-84570
- SPERA, DAVID A.**
Collected papers on wind turbine technology
[NASA-CR-195432] p 447 N95-27970
- SPINA, ERIC F.**
The noise reduction potential of dual-stream coaxial rectangular improperly expanded jet flows
[NASA-CR-197820] p 437 N95-26995
- SPLETTSTOESSER, WOLF R.**
A higher harmonic control test in the DNW to reduce impulsive BVI noise
[HTN-95-61071] p 385 A95-83655
- SPRINGER, GEORGE S.**
Compressive strength of damaged and repaired composite plates
p 442 N95-28484
- SRIDHAR, S.**
Design of a real-time wind turbine simulator using a custom parallel architecture
p 449 N95-27979
- STALLINGS, ROBERT L., JR.**
Measurements of store forces and moments and cavity pressures for a generic store in and near a box cavity at subsonic and transonic speeds
[NASA-TM-4611] p 378 N95-28241
- STARNES, JAMES H., JR.**
Composite fuselage shell structures research at NASA Langley Research Center
p 425 N95-28466
- STAVINHOA, LEO L.**
Mechanism of deposit formation on fuel-wetted hot metal surfaces
[AD-A289847] p 426 N95-28621
- STECK, J. E.**
An exploratory application of neural networks for airfoil design
p 448 N95-26943
- STEGMAIER, J.**
Development of an aeroderivative gas turbine dry low emissions combustion system
[BTN-94-EIX95011441246] p 417 A95-84203
- STEIN, EARL S.**
The controller memory guide. Concepts from the field
[AD-A289263] p 383 N95-26978
- STEINETZ, B. M.**
Numerical analysis of intra-cavity and power-stream flow interaction in multiple gas-turbine disk-cavities
[NASA-TM-106886] p 407 N95-28344
- STEINETZ, BRUCE M.**
Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics
[NASA-TM-106685] p 416 N95-27434
- STEMMER, G.**
Damage occurrence on composites during testing and fleet service: Repair of Airbus aircraft
p 396 N95-27526
- STERIN, E.**
Prediction of fatigue crack growth under constant amplitude and random loading using specimens with multiple cracks
[AD-A291614] p 397 N95-28409
- STEWART, ERIC C.**
Flutter clearance flight tests of an OV-10A airplane modified for wake vortex flight experiments
[NASA-TM-109188] p 366 N95-26381
- STOCKWELL, ALAN E.**
A verification procedure for MSC/NASTRAN Finite Element Models
[NASA-CR-4675] p 392 N95-27371
- STOUT, WAYNE**
Aircraft nosewheel steering simulation
p 412 N95-26944
- STRAIN, J. C.**
Aeroelastic stability of wind turbine blade/aileron systems
p 377 N95-27981
Calculation of design load for the MOD-5A 7.3 mW wind turbine system
p 440 N95-27982
- STRAUB, A. C.**
Ceramic composite attachments for transmission of high-torque loads
[BTN-94-EIX95011441256] p 417 A95-84213
- STREBY, OLIVIER**
A higher harmonic control test in the DNW to reduce impulsive BVI noise
[HTN-95-61071] p 385 A95-83655
- STREITLIEN, K.**
Force and moment on a Joukowski profile in the presence of point vortices
[BTN-95-EIX95262694298] p 434 A95-85469
- STREMEL, PAUL M.**
Effect of Reynolds number and turbulence on airfoil aerodynamics at -90-degree incidence
[HTN-95-42320] p 370 A95-86149
Calculation of three-dimensional (3-D) internal flow by means of the velocity-vorticity formulation on a staggered grid
[NASA-TM-110352] p 376 N95-27258
- STUART, THOMAS D.**
Wind-tunnel tests of an inclined cylinder having helical grooves
[BTN-95-EIX95262694306] p 411 A95-85477
- SUAREZ, J.**
Comparison of resin film infusion, resin transfer molding, and consolidation of textile preforms for primary aircraft structure
p 425 N95-28477
- SUNG, HYUNG JIN**
Prediction of two-dimensional momentumless wake by k-epsilon-gamma model
[BTN-95-EIX95262694299] p 434 A95-85470
- SUTHAR, R. L.**
Mobile domes for TACTIC telescope
p 453 A95-86113
- SUZUKI, KOJIRO**
Reentry technology experiment on the first mission of reentry capsule 'EXPRESS'
p 414 A95-82499
Viscous shock-layer analysis on hypersonic flow over reentry capsule with nonequilibrium chemistry
[ISAS-656] p 436 N95-26739
Wind tunnel experiments on wake flow field behind a reentry capsule from a viewpoint of parachute deployment at supersonic speeds
[ISAS-655] p 374 N95-26740
- SWANSON, G.**
Designers' unified cost model
p 424 N95-28464
- SWANSON, G. D.**
Local design optimization for composite transport fuselage crown panels
p 398 N95-28473
- SWANTON, G.**
Design and development of a test rig for the high frequency testing of rolling sleeve airsprings
[DSTO-TN-0001] p 411 N95-26378
- SWIFT, T.**
Damage tolerance capability
p 388 A95-85898
- SYNDER, RICHARD D.**
A non-iterative grid deformation algorithm for computational fluid dynamics for aerelasticity
[AD-A288298] p 436 N95-26418
- SZETO, K.**
Fractal properties of whitecaps
[HTN-95-92121] p 443 A95-83827
- SZEWCZYK, ALBIN A.**
Effects of three-dimensional imposed 3-D disturbances on bluff-body near wake flows
[AD-A289553] p 374 N95-26757

T

- TAGHAVI, RAY**
Preliminary results and research capabilities of a new jet facility at the University of Kansas
p 412 N95-26951
Visualization of the multiple supersonic jet oscillations by swept focused strobed schlieren technique
p 367 N95-26952
- TAKAGI, SHOHEI**
Observation of traveling waves in the three-dimensional boundary layer along a yawed cylinder
[HTN-95-61064] p 430 A95-83648
- TAKAHASHI, M.**
Experiment of rocket-ram annular combustor
p 412 A95-82324
- TAKAHIRA, MIKINARI**
Rarefied gas numerical wind tunnel: OREX and HOPE
p 427 A95-82391

W

TAKEISHI, K.

Study on the turbine vane and blade for a 1500 C class industrial gas turbine
[BTN-94-EIX95011441254] p 431 A95-84211

TAM, C. K. W.

Screech tones from free and ducted supersonic jets
[HTN-95-51647] p 432 A95-85029

TAMARU, TAKASHI

Numerical simulation of combustion flow around a flame holder with hydrogen injection
[NAL-TR-1233] p 419 N95-26523

TAMURA, HIROBUMI

R & D on HOPE structure p 413 A95-82355

TANAKA, MASAYUKI

Air truth validation of cloud albedo estimated from NOAA advanced very high resolution radiometer data
[HTN-95-A1021] p 443 A95-84526

TANATSUGU, NOBUHIRO

Test results on air turbo ramjet engine for a future space plane p 402 A95-82327

TANEDA, HIROSHI

Hypersonic wind tunnel test of sidewall compression type scramjet inlet p 410 A95-82320

TANGLER, J. L.

Wind-tunnel test of the S814 thick root airfoil
[DE95-000268] p 376 N95-27541

TANGLER, JAMES L.

Horizontal axis wind turbine post stall airfoil characteristics synthesis p 376 N95-27974

TANI, KOUICHIRO

Evaluation of scramjet nozzle performance p 402 A95-82321

TAYLOR, D. W. A.

Geophex airborne unmanned survey system
[DE95-007566] p 392 N95-27440

TAYLOR, HENRY L.

The value of simulation for training
[AD-A289174] p 411 N95-26556

THORSTENSON, CLIFFORD B.

Life cycle costs of alternatives for F-16 printed circuit board diagnosis equipment
[AD-A288744] p 401 N95-28586

TIAN, JUN

Analysis of backscattering from wing and fuselage joints
[HTN-95-71134] p 430 A95-83495

TING, L.

Acoustic field in unsteady moving media
[NASA-CR-198162] p 438 N95-27179

TOBIAS, M.

Advanced wing design survivability testing and results p 400 N95-28488

TODD, S. M.

ACT/ICAPS: Thermoplastic composite activities p 421 N95-28274

TOGAWA, MORITO

An advanced scramjet propulsion concept for A 350 MG SSTO space plane p 402 A95-82325

TOKUNAGA, TATSURU

An advanced scramjet propulsion concept for A 350 MG SSTO space plane p 402 A95-82325

TOLPADI, ANIL K.

Combustion system CFD modeling at GE Aircraft Engines p 439 N95-27889

TOMIKE, JUNICHIRO

A conceptual design of hypersonic research vehicle with subscale scramjet engine p 384 A95-82482

TOMITA, HIROSHI

Flight evaluation of DGPS and DGPS-INS navigation systems p 382 A95-82462

TORELLA, G.

Artificial intelligence for turboprop engine maintenance
[HTN-95-92313] p 404 A95-85357

TRABOCCO, R.

Field repair materials for naval aircraft p 394 N95-27514

TRABOCCO, R. E.

Navy composite maintenance and repair experience p 424 N95-28446

TRACY, M. B.

Measurements of store forces and moments and cavity pressures for a generic store in and near a box cavity at subsonic and transonic speeds
[NASA-TM-4611] p 378 N95-28241

TRAWINSKI, DAVID

Application of fiber-reinforced bismaleimide materials to aircraft nacelle structures p 397 N95-28278

TREGO, LINDA E.

Maintenance programs
[HTN-95-92310] p 365 A95-85354

Aircraft stripping and painting
[HTN-95-92311] p 365 A95-85355

TREMANTE, A.

Contribution of thermal radiation to the temperature profile of ceramic composite materials
[BTN-94-EIX95011441252] p 417 A95-84209

TRESLER, CARL A.

Experimental investigation of inlet-combustor isolators for a dual-mode scramjet at a Mach number of 4
[NASA-TP-3502] p 407 N95-28343

TRIANTAFYLLOU, M. S.

Force and moment on a Joukowski profile in the presence of point vortices
[BTN-95-EIX95262694298] p 434 A95-85469

TROPIS, A.

Composite or metallic bolted repairs on self-stiffened carbon wing panel of the commuter ATR72 design criteria, analysis, verification by test p 396 N95-27525

TSIANG, T. H.

Process and control systems for composites manufacturing p 420 N95-28267

TSUJII, TOSHIKI

Flight evaluation of DGPS and DGPS-INS navigation systems p 382 A95-82462

Flight evaluation of GPS/DGPS sensor systems installed in NAL Do228
[NAL-TR-1230] p 382 N95-26585

TSURI, SHUICHI

Life evaluation of a low power arcjet thruster p 403 A95-82337

TULAPURKARA, E. G.

Boundary layer studies over an S-blade
[HTN-95-92261] p 434 A95-85305

TUTTLE, M.

Local design optimization for composite transport fuselage crown panels p 398 N95-28473

TUTTLE, M. M.

Investigation of static and cyclic bearing failure mechanisms for GR/EP laminates p 422 N95-28427

U

UEDA, A.

Development of 70MW class superconducting generators
[BTN-94-EIX95011440854] p 429 A95-82905

UEDA, SHUICHI

Evaluation of scramjet nozzle performance p 402 A95-82321

Experiment and analysis on heat transfer of a scramjet leading edge model p 403 A95-82420

UEMATSU, KAZUO

Life evaluation of a low power arcjet thruster p 403 A95-82337

UESUGI, KUNINORI

How 'HITEN's' aerobraking experiments were carried out p 415 A95-82553

Aero-thermodynamic flight environment at HITEN aerobrace experiment p 415 A95-82554

URITA, AKIRA

Hypersonic flow simulation with thermoelectric effect p 368 A95-82669

USTILOVSKY, SH.

Prediction of fatigue crack growth under constant amplitude and random loading using specimens with multiple cracks
[AD-A291614] p 397 N95-28409

V

VALLURI, SIDDHARTHA

Flow past a symmetric wedge with forward splitter plate p 427 A95-82406

VAN DER WALL, B. G.

On the influence of time-varying flow velocity on unsteady aerodynamics
[HTN-95-61073] p 369 A95-83657

VETH, MICHAEL J.

Advanced formation flight control
[AD-A289271] p 409 N95-26981

VISBAL, MIGUEL R.

Crossflow topology of vortical flows
[HTN-95-51664] p 432 A95-85046

VLCEK, KEVIN M.

An investigation of the AFIT 2-inch shock tube as a flow source for supersonic testing
[AD-A289246] p 412 N95-26966

VOLAKIS, JOHN L.

Hybrid finite element-modal analysis of jet engine inlet scattering
[BTN-95-EIX95242673665] p 427 A95-82259

VOS, E. A.

Flex cycle combustor development and demonstration
[BTN-94-EIX95011441245] p 417 A95-84202

VOSTEEN, LOUIS F.

COINS: A composites information database system p 453 N95-28465

WADA, YASUHIRO

NAL aerothermodynamic probing and CFD verification mission in OREX experiment p 368 A95-82413

Practical formulation of a positively conservative scheme
[HTN-95-51668] p 433 A95-85050

WAI, R.

Neuro-controllers for adaptive helicopter training
[SAE PAPER 932535] p 379 A95-84557

WAKAMATSU, YOSHIO

Experiment and analysis on heat transfer of a scramjet leading edge model p 403 A95-82420

WAKE, BRIAN E.

Evaluation of a doubly-swept blade tip for rotorcraft noise reduction
[NASA-CR-189677] p 452 N95-28264

WALIGORA, SHARON

Software process improvement in the NASA software engineering laboratory
[AD-A289912] p 450 N95-28627

WALKER, T. H.

Tension fracture of laminates for transport fuselage. Part 1: Material screening p 398 N95-28471

Local design optimization for composite transport fuselage crown panels p 398 N95-28473

WALTER, R. W.

Investigation of static and cyclic bearing failure mechanisms for GR/EP laminates p 422 N95-28427

WANAMAKER, JOHN L.

Process and control systems for composites manufacturing p 420 N95-28267

WANG, J. A.

Computational/experimental investigation of staged injection into a Mach 2 flow
[HTN-95-51646] p 432 A95-85028

WANG, J. T.

Technology integration box beam failure study p 441 N95-28468

WANG, JIANLIANG

Scheduling of local nonlinear control laws by exogenous signals - an application to flight control
[BTN-95-EIX95262694059] p 447 A95-85675

WANG, LI-XIN

Nonlinear decoupling control study for aircraft maneuvering flight
[HTN-95-71130] p 408 A95-83491

WANG, Y. H.

Effect of squeeze film damper land geometry on damper performance
[HTN-95-92247] p 434 A95-85291

WANG, ZICAI

Nonlinear observer and its application in flight control p 447 A95-82449

WANHILL, R. J. H.

Flight simulation fatigue crack growth testing of aluminum alloys
[HTN-95-00652] p 418 A95-84731

Status and prospects for aluminium-lithium alloys in aircraft structures p 387 A95-85893

WANTUCK, P. J.

A laboratory scale supersonic combustive flow system
[DE95-006347] p 420 N95-27851

WATANABE, NAUYUKI

Development and flight results of fiber reinforced balloon p 384 A95-82511

WATANABE, SHIGEYA

An experimental investigation of scramjet nozzle flow p 402 A95-82322

A concept of a hypersonic flight experiment of a winged vehicle p 414 A95-82477

WATANABE, YASUO

NAL aerothermodynamic probing and CFD verification mission in OREX experiment p 368 A95-82413

WATANUKI, TADAHARU

Hypersonic thermal protection with mass injection at angle of attack p 414 A95-82414

WEHR, T.

Aircraft measurements of CLO and HCL during EASOE 1991/92
[HTN-95-00721] p 444 A95-86291

WEIDEMAN, MARK H.

Resin transfer molding of textile preforms for aircraft structural applications p 421 N95-28276

WEIDNER, JOHN P.

Experimental investigation of inlet-combustor isolators for a dual-mode scramjet at a Mach number of 4
[NASA-TP-3502] p 407 N95-28343

WEIR, DONALD S.

Aircraft noise prediction program theoretical manual: Rotorcraft System Noise Prediction System (ROTONET), part 4
[NASA-TM-83199-PT-4] p 451 N95-26392

WENTZ, W. H., JR.

Comparative wind tunnel tests of NACA 23024 airfoils with several aileron and spoiler configurations
p 376 N95-27976

WENTZ, WILLIAM H.

AIAA Techfest 20 Proceedings
[NIAR-94-1] p 367 N95-26941

WESTBROOK, STEVEN R.

Mechanism of deposit formation on fuel-wetted hot metal surfaces
[AD-A289847] p 426 N95-28621

WESTBYE, C. J.

Study of heat transfer rates during quenching of a hot tube under microgravity p 428 A95-82641

WHALING, K. N.

Stationary premixed flames in spherical and cylindrical geometries
[HTN-95-42336] p 418 A95-86165

WHITEHEAD, R. S.

C-130 Advanced Technology Center wing box conceptual design/cost study p 423 N95-28437

WHITTAKER, THOMAS

Optimal trajectories for hypersonic launch vehicles
[HTN-95-61120] p 415 A95-84884

WICKER, RYAN B.

Near field of a coaxial jet with and without axial excitation
[HTN-95-42332] p 372 A95-86161

WILCOX, PETER

Further investigations of icing effects on an advanced high-lift multi-element airfoil
[NASA-TM-106947] p 381 N95-27762

WILDER, GREG

User documentation of the CTA program
[AD-A289508] p 375 N95-26854

WILDER, M. C.

Interferometric investigations of compressible dynamic stall over a transiently pitching airfoil
[HTN-95-42338] p 372 A95-86167

WILLDEN, KURTIS

Composite fuselage crown panel manufacturing technology p 399 N95-28474
Characterization and manufacture of braided composites for large commercial aircraft structures p 426 N95-28478

WILLIS, ZDENKA S.

Naval Aviation System TEAM mapping, charting, and geodesy handbook
[AD-A288590] p 446 N95-26841

WILLMARTH, W. W.

Measurements of vortex pair interaction with a clean or contaminated free surface
[BTN-94-EIX95011441063] p 429 A95-82798

WILSON, D. R.

NASA-ACEE/Boeing 737 graphite-epoxy horizontal stabilizer service p 400 N95-28489

WILSON, JACK

Optimization of wave rotors for use as gas turbine engine topping cycles
[NASA-TM-106951] p 406 N95-27860

WILSON, JOHN W.

Radiation safety aspects of commercial high-speed flight transportation
[NASA-TP-3524] p 453 N95-26427

WILSON, KENNETH J.

Suppressor of oscillations in airframe cavities
[AD-D017265] p 388 N95-26507

WILSON, ROBERT E.

Preliminary analysis of dynamic stall effects on a 91-meter wind turbine rotor p 376 N95-27975

WIRTH, M.

Two dimensional stratospheric aerosol distributions during EASOE
[HTN-95-00726] p 444 A95-86296

WOLF, K.

External patch repair of CFRP/honeycomb sandwich p 395 N95-27522

WON, I. J.

Geophex airborne unmanned survey system
[DE95-007566] p 392 N95-27440

WOODWARD, M. R.

Applications of a damage tolerance analysis methodology in aircraft design and production p 426 N95-28483

WU, CHUNG-HUA

A general theory of two- and three-dimensional rotational flow in subsonic and transonic turbomachines
[NASA-CR-4496] p 377 N95-28003

WU, EDWARD M.

Proof test methodology for composites p 424 N95-28445

WU, J.-S.

Sphere wakes at moderate Reynolds numbers in a turbulent environment
[HTN-95-42331] p 372 A95-86160

X

XUJUN, HUANG

Numerical investigation to S-inlet flows (Numerical simulation study of S-inlet flows)
[AD-A289590] p 374 N95-26713

Y

YAGI, Y.

Development of 70MW class superconducting generators
[BTN-94-EIX95011440854] p 429 A95-82905

YAJIMA, N.

Polar Patrol Balloon system and preliminary experimental results p 368 A95-82513

YAJIMA, NOBUYUKI

Development and flight results of fiber reinforced balloon p 384 A95-82511

YAMAGAMI, T.

Polar Patrol Balloon system and preliminary experimental results p 368 A95-82513

YAMAMOTO, MASAHIKO

Evaluation of scramjet nozzle performance p 402 A95-82321

YAMAMOTO, SHIRO

Hypersonic thermal protection with mass injection at angle of attack p 414 A95-82414

YAMAMOTO, TAKESHI

Numerical simulation of combustion flow around a flame holder with hydrogen injection
[NAL-TR-1233] p 419 N95-26523

YAMANAKA, TATSUO

An advanced scramjet propulsion concept for A 350 MG SSTO space plane p 402 A95-82325

YAO, AKIRA

Experimental investigation of composite channel heat pipe operation in micro-gravity environment p 428 A95-82645

YAO, YU

Nonlinear observer and its application in flight control p 447 A95-82449

YASUI, HIDEMI

NAL aerothermodynamic probing and CFD verification mission in OREX experiment p 368 A95-82413

YATSUYANAGI, N.

Experiment of rocket-ram annular combustor p 412 A95-82324

YEH, DUN-YANN

Transonic flutter suppression using active acoustic excitations
[BTN-95-EIX95262694310] p 408 A95-85481

YEN, JING G.

Effects of blade tip shape on dynamics, cost, weight, aerodynamic performance, and aeroelastic response
[HTN-95-61074] p 369 A95-83658

YING, S. X.

A fixed time performance evaluation of parallel CFD applications
[DE94-014240] p 436 N95-26445

YOKOYAMA, HISASHI

Flight evaluation of DGPS and DGPS-INS navigation systems p 382 A95-82462

YONEMOTO, KOICHI

Hypersonic trajectory control of aerospace plane with integrated SCRAMJET engine p 413 A95-82384

Air data sensors for atmospheric reentry flight test of winged space vehicle p 413 A95-82412

A conceptual design of hypersonic research vehicle with sub-scale scramjet engine p 384 A95-82482

YOSEF, REUVEN

A review of falconry as a bird control technique with recommendations for use at the Shuttle Landing Facility, John F. Kennedy Space Center, Florida, USA
[NASA-TM-110142] p 381 N95-27859

YOSHIKAWA, TAKAO

Life evaluation of a low power arcjet thruster p 403 A95-82337

YOSHIZAWA, AKIRA

Hypersonic wind tunnel test of sidewall compression type scramjet inlet p 410 A95-82320

YOUNG, A.

Adhesively bonded composite patch repair of cracked aluminum alloy structures p 393 N95-27507

YOUNG, D. P.

TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual
[NASA-CR-4349] p 377 N95-28230

TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document
[NASA-CR-4348] p 378 N95-28265

YOUNGBLUT, CHRISTINE

The value of simulation for training
[AD-A289174] p 411 N95-26556

YU, TAO

A numerical method for unsteady transonic flow about wings with control surfaces
[AD-A289631] p 375 N95-26859

YUAN, K. A.

Aeroelasticity and structural optimization of composite helicopter rotor blades with swept tips
[NASA-CR-4665] p 397 N95-28262

YUE, LOU

Study on a scheme for the prolongation of microgravity time of balloon-borne drop capsule p 414 A95-82515

Z

ZABINSKY, Z.

Local design optimization for composite transport fuselage crown panels p 398 N95-28473

ZACHARIAS, GREG L.

Intelligent flight trainer for initial rotary wing training
[SAE PAPER 932536] p 386 A95-84558

ZAKARIA, ZAIDI B.

Surface interference in Rayleigh scattering measurements near forebodies
[HTN-95-51670] p 433 A95-85052

ZELKOWITZ, MARVIN

Software process improvement in the NASA software engineering laboratory
[AD-A289912] p 450 N95-28627

ZERKLE, D. K.

A laboratory scale supersonic combustive flow system
[DE95-006347] p 420 N95-27851

ZERKLE, RONALD D.

A summary of computational experience at GE Aircraft Engines for complex turbulent flows in gas turbines p 439 N95-27885

ZHANG, JIANBAI

A numerical method for unsteady transonic flow about wings with control surfaces
[AD-A289631] p 375 N95-26859

ZHAO, J. Y.

Subharmonic and quasi-periodic motions of an eccentric squeeze film damper-mounted rigid rotor
[BTN-94-EIX95011440601] p 429 A95-82982

ZHI-XUM, XIA

An inverse design method of transonic airfoil and wing
[HTN-95-71128] p 385 A95-83489

ZHU, GUO-RUI

Non-linear viscoelastic-plastic constitutive relations for an aeronautical PMMA
[HTN-95-71132] p 385 A95-83493

ZHU, XI-XIONG

Non-linear viscoelastic-plastic constitutive relations for an aeronautical PMMA
[HTN-95-71132] p 385 A95-83493

ZI-QIANG, ZHU

An inverse design method of transonic airfoil and wing
[HTN-95-71128] p 385 A95-83489

ZIMMERMAN, D. K.

Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system p 440 N95-27983

ZINGG, D. W.

Compressible Navier-Stokes computations of multielement airfoil flows using multiblock grids
[HTN-95-42327] p 371 A95-86156

ZISCHKA, PETER J.

Unique considerations in the design and experimental evaluation of tailored wings with elastically produced chordwise camber p 423 N95-28436

ZMIERCZAK, TOMASZ

Photoacoustic chambers for studying solids and gases: Theory and practical examples
[IFTR-39/1994] p 412 N95-26837

ZOLADZ, T.

Bearing defect signature analysis using advanced nonlinear signal analysis in a controlled environment
[NASA-TM-108491] p 441 N95-28364

ZYSKOWSKI, MICHAEL K.

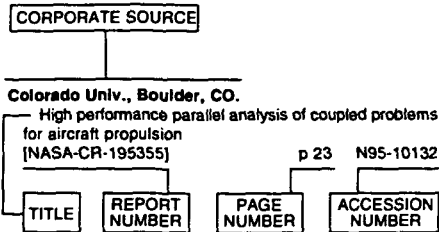
Incorporating biplane wing theory into a large, subsonic, all-cargo transport p 391 N95-26956

CORPORATE SOURCE INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 321)

September 1995

Typical Corporate Source Index Listing



Listings in this index are arranged alphabetically by corporate source. The title of the document is used to provide a brief description of the subject matter. The page number and the accession number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document.

A

Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

Composite Repair of Military Aircraft Structures [AGARD-CP-550] p 392 N95-27504

AEPKO, Inc., Rockville, MD.

AH-1F COBRA rewire program MANPRINT analysis [AD-A289190] p 391 N95-27018

Aeronautical Systems Div., Eglin AFB, FL.

User documentation of the CTA program [AD-A289508] p 375 N95-26854

Aerospatiale, Toulouse (France).

Composite or metallic bolted repairs on self-stiffened carbon wing panel of the commuter ATR72 design criteria, analysis, verification by test p 396 N95-27525

Air Force Inst. of Tech., Wright-Patterson AFB, OH.

Development of a nonlinear simulation for the McDonnell Douglas F-15 Eagle with a longitudinal TECS control-law [AD-A288610] p 388 N95-26481

A numerical model to predict the fate of jettisoned aviation fuel [AD-A289336] p 419 N95-26842

A comparison of the Neal-Smith and omega Tau function, zeta function and tau function flying qualities criteria [AD-A289503] p 390 N95-26844

An analysis of the KC-135 three-person cockpit [AD-A289540] p 390 N95-26873

The photo-realistic AFIT virtual cockpit [AD-A289376] p 390 N95-26876

Classification of ultra high range resolution radar using decision boundary analysis [AD-A289378] p 437 N95-26877

Stall precursor study of high frequency data for three high speed, swept compressor rotors [AD-A289379] p 406 N95-26878

EASY-SIM: A visual simulation system software architecture with an Ada 9X application framework [AD-A289325] p 448 N95-26895

Analysis and simulation of narrowband GPS jamming using digital excision temporal filtering [AD-A289328] p 383 N95-26898

Performance characterization of a highly-offset diffuser with and without blowing vortex generator jets [AD-A289334] p 375 N95-26901

A gain scheduling optimization method using genetic algorithms [AD-A289306] p 448 N95-26920

Electro-hydrostatic actuator controller design using quantitative feedback theory [AD-A289220] p 409 N95-26957

A quantitative feedback theory FCS design for the subsonic envelope of the VISTA F-16 including configuration variation [AD-A289221] p 409 N95-26958

An investigation of the AFIT 2-inch shock tube as a flow source for supersonic testing [AD-A289246] p 412 N95-26966

Advanced formation flight control [AD-A289271] p 409 N95-26981

An integrated GPS/INS/BARO and radar altimeter system for aircraft precision approach landings [AD-A289280] p 383 N95-26985

Survey and implementation of commercial manual controllers for a generic telerobotics architecture [AD-A289215] p 449 N95-26990

Flight control design using mixed H2/micron optimization [AD-A289288] p 410 N95-27036

Implementation and demonstration of a multiple model adaptive estimation failure detection system for the F-16 [AD-A289301] p 391 N95-27042

Life cycle costs of alternatives for F-16 printed circuit board diagnosis equipment [AD-A288744] p 401 N95-28586

Development of a TECS control-law for the lateral directional axis of the McDonnell Douglas F-15 Eagle [AD-A289771] p 410 N95-28598

Air Force Systems Command, Wright-Patterson AFB, OH.

Numerical investigation to S-inlet flows (Numerical simulation study of S-inlet flows) [AD-A289590] p 374 N95-26713

Plate manipulators [AD-A289601] p 374 N95-26719

A numerical method for unsteady transonic flow about wings with control surfaces [AD-A289631] p 375 N95-26859

Allison Engine Co., Indianapolis, IN.

Propulsion system assessment for very high UAV under ERAST [NASA-CR-195469] p 406 N95-27866

American Inst. of Aeronautics and Astronautics, Washington, DC.

Proceedings of the AIAA/FAA joint symposium on general aviation systems [AD-A289830] p 368 N95-28610

Analytical Services and Materials, Inc., Hampton, VA.

COINS: A composites information database system [AD-A289631] p 453 N95-28465

Army Aeromedical Research Lab., Fort Rucker, AL.

The effects of UH-1 experience on UH-60 simulator performance: A preliminary study [AD-A289457] p 391 N95-26993

Army Aviation Systems Command, Hampton, VA.

Development and validation of a blade-element mathematical model for the AH-64A Apache helicopter [NASA-TM-108863] p 367 N95-26710

Army Aviation Systems Command, Moffett Field, CA.

An investigation of the effects of pitch-roll (de)coupling on helicopter handling qualities [NASA-TM-110349] p 409 N95-26773

Army Aviation Technical Test Center, Fort Rucker, AL.

Test operations procedure (TOP) 7-3-534 airworthiness testing of fixed wing aircraft: Asymmetric power testing [AD-A289458] p 391 N95-26994

Army Materiel Command, Aberdeen Proving Ground, MD.

Utilization of composite materials by the US Army: A look ahead p 421 N95-28421

Army Natick Research and Development Command, MA.

The performance of cargo airdrop systems using g-12E parachutes: Statistical determination of minimum altitude [AD-A291666] p 381 N95-28454

Army Research Lab., Cleveland, OH.

Vibration analysis of a split path gearbox [NASA-TM-106875] p 438 N95-27855

Atlantic Research Corp., Alexandria, VA.

Through-the Thickness(R) braided composites for aircraft applications p 421 N95-28273

B

Battelle Memorial Inst., Columbus, OH.

Development of repair processes and sources for C/KC-135 aircraft windows/windshields [AD-A288348] p 367 N95-26629

Bionetics Corp., Hampton, VA.

Measurement and prediction of broadband noise from large horizontal axis wind turbine generators p 451 N95-27990

Boeing Aerospace Co., Seattle, WA.

Comparative performance tests on the Mod-2, 2.5-mW wind turbine with and without vortex generators p 377 N95-27978

Comparison of measured and calculated dynamic loads for the Mod-2 2.5 mW wind turbine system p 440 N95-27983

Use of blade pitch control to provide power train damping for the Mod-2, 2.5-mW wind turbine p 440 N95-27986

Boeing Commercial Airplane Co., Seattle, WA.

Local design optimization for composite transport fuselage crown panels p 398 N95-28473

Composite fuselage crown panel manufacturing technology p 399 N95-28474

Impact damage resistance of composite fuselage structure, part 1 p 399 N95-28482

NASA-ACEE/Boeing 737 graphite-epoxy horizontal stabilizer service p 400 N95-28489

Noise exposure reduction of advanced high-lift systems [NASA-CR-195077] p 452 N95-28670

Boeing Defense and Space Group, Philadelphia, PA.

Application of advanced material systems to composite frame elements p 422 N95-28432

Characterization and manufacture of braided composites for large commercial aircraft structures p 426 N95-28478

Boeing Defense and Space Group, Seattle, WA.

Investigation of static and cyclic bearing failure mechanisms for GR/EP laminates p 422 N95-28427

Boeing Military Airplane Development, Seattle, WA.

TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. User's manual [NASA-CR-4349] p 377 N95-28230

TranAir: A full-potential, solution-adaptive, rectangular grid code for predicting subsonic, transonic, and supersonic flows about arbitrary configurations. Theory document [NASA-CR-4348] p 378 N95-28265

Bombardier, Inc., Montreal (Quebec).

Design and structural validation of CF116 upper wing skin boron doubler p 393 N95-27510

British Aerospace Defence Ltd., Preston (England).

Composite repair of composite structures p 395 N95-27521

C

California Univ., Davis, CA.

Unique considerations in the design and experimental evaluation of tailored wings with elastically produced chordwise camber p 423 N95-28436

California Univ., Los Angeles, CA.

Aeroelasticity and structural optimization of composite helicopter rotor blades with swept tips [NASA-CR-4665] p 397 N95-28262

- Carnegie-Mellon Univ., Pittsburgh, PA.**
Software process improvement in the NASA software engineering laboratory
[AD-A289912] p 450 N95-28627
- Ceramic Composites, Inc., Millersville, MD.**
Ceramic composite combustor cans for expendable turbine engines
[AD-A289551] p 407 N95-28646
- Clemson Univ., SC.**
A general theory of two- and three-dimensional rotational flow in subsonic and transonic turbomachines
[NASA-CR-4496] p 377 N95-28003
- Construcciones Aeronauticas S.A., Madrid (Spain).**
Repairs of CFC primary structures
p 396 N95-27527
- Coordinating Research Council, Inc., Atlanta, GA.**
The effect of aviation fuels containing low amounts of static dissipater additive on electrostatic charge generation
[AD-A280075] p 420 N95-28152

D

- DACCO SCI, Inc., Columbia, MD.**
The use of electrochemistry and ellipsometry for identifying and evaluating corrosion on aircraft
[AD-A288536] p 381 N95-27186
- DASCON Engineering, Bay Village, OH.**
Collected papers on wind turbine technology
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p 393 N95-27508
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p 393 N95-27507
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p 395 N95-27518
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[DSTO-TN-0001] p 411 N95-26378
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[DSTO-TR-0135] p 388 N95-26389
- Characteristics of the turbine inlet temperature sensing circuit for the T56 turbo-prop engine**
[DSTO-TR-0095] p 405 N95-26424
- Bonded composite repair of metallic aircraft components: Overview of Australian activities**
p 392 N95-27505
- Scarf repairs to graphite/epoxy components**
p 396 N95-27523
- A review of Australian and New Zealand investigations on aeronautical fatigue during the period Apr. 1993 - Mar. 1995**
[AR-009-202] p 397 N95-27918
- Tie-down trials involving a Sikorsky S-70B-2 helicopter**
[DSTO-TR-0132] p 400 N95-28567
- Delaware Univ., Newark, DE.**
The effect of material heterogeneity in curved composite beams for use in aircraft structures
p 422 N95-28426
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Unmanned aerial vehicles, 1994 master plan
[AD-A291628] p 398 N95-28411
- Department of the Navy, Washington, DC.**
Suppressor of oscillations in airframe cavities
[AD-D017265] p 388 N95-26507
- Balanced on air aircraft**
[AD-D017251] p 389 N95-26537
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[NASA-CR-197785] p 445 N95-26669
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p 394 N95-27515
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p 395 N95-27517
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p 396 N95-27526
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C-2

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[NASA-CR-189077] p 441 N95-27999
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p 399 N95-28480
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p 438 N95-27354

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p 395 N95-27522

F

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[AD-A289015] p 384 N95-27903
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[AD-A289263] p 383 N95-26978
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[AD-A280074] p 412 N95-28151
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[NASA-CR-198722] p 424 N95-28462
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G

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[GAO/NSIAD-95-112] p 397 N95-27910
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Development of a low-cost, modified resin transfer molding process using elastomeric tooling and automated preform fabrication
p 420 N95-28268
- General Dynamics Corp., Fort Worth, TX.**
Applications of a damage tolerance analysis methodology in aircraft design and production
p 426 N95-28483
- General Electric Co., Cincinnati, OH.**
A summary of computational experience at GE Aircraft Engines for complex turbulent flows in gas turbines
p 439 N95-27885
- Combustion system CFD modeling at GE Aircraft Engines**
p 439 N95-27889
- General Electric Co., Philadelphia, PA.**
Aeroelastic stability of wind turbine blade/aileron systems
p 377 N95-27981

- Control system design for the MOD-5A 7.3 mW wind turbine generator**
p 440 N95-27985
- Variable speed generator application on the MOD-5A 7.3 mW wind turbine generator**
p 440 N95-27989
- General Electric Co., Schenectady, NY.**
Calculation of design load for the MOD-5A 7.3 mW wind turbine system
p 440 N95-27982
- Geophex Ltd., Raleigh, NC.**
Geophex airborne unmanned survey system
[DE95-007566] p 392 N95-27440
- Georgia Inst. of Tech., Atlanta, GA.**
A FEAM based methodology for analyzing composite patch repairs of metallic structures
p 394 N95-27511
- Operator modeling in commercial aviation: Cognitive models, intelligent displays, and pilot's assistants**
[NASA-CR-198609] p 401 N95-28203
- Grumman Aerospace Corp., Bethpage, NY.**
Comparison of resin film infusion, resin transfer molding, and consolidation of textile preforms for primary aircraft structure
p 425 N95-28477
- Advanced wing design survivability testing and results**
p 400 N95-28488

H

- Hercules Aerospace Co., Magna, UT.**
Advanced tow placement of composite fuselage structure
p 420 N95-28271
- Honeywell, Inc., Minneapolis, MN.**
Micro-time stress measurement device development
[AD-A289511] p 448 N95-26845
- Houston Univ., TX.**
Basic studies in turbulent shear flows
[AD-A29145] p 437 N95-26998

I

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Strategy in the commercial aircraft industry in the United States: A comparison of decisionmaking by McDonnell-Douglas and Boeing aircraft companies from 1977-1983
[AD-A288289] p 366 N95-26409
- Surviving the peace. Lessons learned from the aircraft industry in the 1920s and 1930s**
[AD-A288284] p 366 N95-26455
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Acoustic field in unsteady moving media
[NASA-CR-198162] p 438 N95-27179
- Response of multi-panel assembly to noise from a jet in forward motion**
[NASA-CR-198164] p 442 N95-28673
- Institute for Defense Analyses, Alexandria, VA.**
The value of simulation for training
[AD-A289174] p 411 N95-26556
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[AD-A291614] p 397 N95-28409

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K

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p 390 N95-26942
- Design of a high altitude long endurance aircraft with manufacturing considerations**
p 391 N95-26947
- Prevention and control of inlet unstair using an SR-71 simulation**
p 367 N95-26948
- An easy way to analyze longitudinal and lateral-directional trim problems with AEO or OEI**
p 409 N95-26949
- Preliminary results and research capabilities of a new jet facility at the University of Kansas**
p 412 N95-26951

L

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[DE95-008060] p 441 N95-28139

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Aircraft nosewheel steering simulation
p 412 N95-26944

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Evaluation of patch effectiveness in repairing aircraft components
p 394 N95-27513

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Aircraft fuel system lightning protection design and qualification test procedures development
[AD-A288401] p 380 N95-26497

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Process and control systems for composites manufacturing
p 420 N95-28267

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Structural modification and repair of C-130 wing structure using bonded composites
p 394 N95-27512
Structural testing of the technology integration box beam
p 441 N95-28467
Advanced textile applications for primary aircraft structures
p 399 N95-28476

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A verification procedure for MSC/NASTRAN Finite Element Models
[NASA-CR-4675] p 392 N95-27371

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Rapid repair of large area damage to contoured aircraft structures
p 394 N95-27516

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Determining GPS average performance metrics
p 383 N95-27791

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[NASA-CR-198165] p 449 N95-27246

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[NASA-CR-198563] p 454 N95-28038

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p 424 N95-28443

M

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p 397 N95-28278

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Anechoic wind tunnel study of turbulence effects on wind turbine broadband noise
p 451 N95-27992

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Numerical simulation of the SOFIA flow field
[NASA-CR-197757] p 436 N95-26589

Aeroelasticity of wing and wing-body configurations on parallel computers
[NASA-CR-197756] p 389 N95-26590

Computational analysis of forebody tangential slot blowing on the high alpha research vehicle
[NASA-CR-197754] p 389 N95-26591

Supersonic transport grid generation, validation, and optimization
[NASA-CR-197752] p 448 N95-26648

CFD research, parallel computation and aerodynamic optimization
[NASA-CR-197748] p 373 N95-26649

Design and testing of low sonic boom configurations and an oblique all-wing supersonic transport
[NASA-CR-197744] p 389 N95-26651

Numerical simulation of the flow about the F-18 HARV at high angle of attack
[NASA-CR-197755] p 374 N95-26735

Development of an upwind, finite-volume code with finite-rate chemistry
[NASA-CR-197747] p 374 N95-26760

Computational support of the laminar flow supersonic wind tunnel, CNSFV code development, Maglev, and grid generation
[NASA-CR-197750] p 411 N95-26775

Turbomachinery design and tonal acoustics computations
[NASA-CR-197749] p 406 N95-26777

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[NASA-CR-197745] p 390 N95-26813

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ACT/ICAPS: Thermoplastic composite activities
p 421 N95-28274

Analysis techniques for the prediction of springback in formed and bonded composite components
p 421 N95-28289

Development of composite carrythrough bulkhead
p 423 N95-28438

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p 439 N95-27886

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p 451 N95-27991

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[LC-94-68678] p 446 N95-27156

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[HTN-95-00722] p 444 A95-86292

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[HTN-95-61120] p 415 A95-84884

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[HTN-95-51648] p 432 A95-85030

Practical formulation of a positively conservative scheme
[HTN-95-51668] p 433 A95-85050

Effect of Reynolds number and turbulence on airfoil aerodynamics at -90-degree incidence
[HTN-95-42320] p 370 A95-86149

Reduction of blade-vortex interaction noise through porous leading edge
[HTN-95-42324] p 371 A95-86153

Interferometric investigations of compressible dynamic stall over a transiently pitching airfoil
[HTN-95-42338] p 372 A95-86167

Simulation model of the integrated flight/pushover control system, displays, and propulsion system for ASTOVL lift-lan aircraft
[NASA-TM-108866] p 405 N95-26412

Flightpath synthesis and HUD scaling for V/STOL terminal area operations
[NASA-TM-110348] p 383 N95-26587

The lift-lan aircraft: Lessons learned
[NASA-CR-196694] p 392 N95-27143

Calculation of three-dimensional (3-D) internal flow by means of the velocity-vorticity formulation on a staggered grid
[NASA-TM-110352] p 376 N95-27258

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p 415 A95-85774

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p 415 A95-85807

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[HTN-95-61071] p 385 A95-83655

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[HTN-95-51646] p 432 A95-85028

Screech tones from free and ducted supersonic jets
[HTN-95-51647] p 432 A95-85029

Shear buckling response of tailored composite plates
[HTN-95-51680] p 418 A95-85062

Nonreflective boundary conditions for high-order methods
[HTN-95-42328] p 371 A95-86157

Quantitative investigation of compressible mixing: Staged transverse injection into Mach 2 flow
[HTN-95-42330] p 404 A95-86159

An overview of millimeter-wave spectroscopic measurements of chlorine monoxide at Thule, Greenland, February-March, 1992: Vertical profiles, diurnal variation, and longer-term trends
[HTN-95-00722] p 444 A95-86292

Flutter clearance flight tests of an OV-10A airplane modified for wake vortex flight experiments
[NASA-TM-109168] p 366 N95-26381

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[NASA-TP-3516] p 373 N95-26382

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[NASA-TM-83199-PT-4] p 451 N95-26392

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[NASA-TP-3524] p 453 N95-26427

Incorporating biplane wing theory into a large, subsonic, all-cargo transport
p 391 N95-26956

A study of workstation computational performance for real-time flight simulation
[NASA-TM-109184] p 449 N95-27241

Hardware cleanliness methodology and certification
p 419 N95-27656

Modeling of aircraft unsteady aerodynamic characteristics. Part 2: Parameters estimated from wind tunnel data
[NASA-TM-110161] p 410 N95-27839

A numerical study of fundamental shock noise mechanisms
[NASA-TM-110608] p 451 N95-27908

Measurements of store forces and moments and cavity pressures for a generic store in and near a box cavity at subsonic and transonic speeds
[NASA-TM-4611] p 378 N95-28241

Resin transfer molding of textile preforms for aircraft structural applications
p 421 N95-28276

- Experimental investigation of inlet-combustor isolators for a dual-mode scramjet at a Mach number of 4 [NASA-TP-3502] p 407 N95-28343
- Effects of floor location on response of composite fuselage frames p 423 N95-28439
- Overview of the ACT program p 424 N95-28463
- Designers' unified cost model p 424 N95-28464
- Composite fuselage shell structures research at NASA Langley Research Center p 425 N95-28466
- Technology integration box beam failure study p 441 N95-28468
- Development of stitched/RTM composite primary structures p 425 N95-28469
- Test and analysis results for composite transport fuselage and wing structures p 398 N95-28470
- Tension fracture of laminates for transport fuselage. Part 1: Material screening p 398 N95-28471
- Recent progress in NASA Langley textile reinforced composites program p 425 N95-28475
- Effect of low-speed impact damage and damage location on behavior of composite panels p 426 N95-28481
- Damage tolerance of a geodesically stiffened advanced composite structural concept for aircraft structural applications p 399 N95-28487
- Study of potential aerodynamic benefits from spanwise blowing at wingtip [NASA-TP-3515] p 378 N95-28669
- Numerical study to assess sulfur hexafluoride as a medium for testing multielement airfoils [NASA-TP-3496] p 378 N95-28674
- National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.**
- Structure of supersonic jet flow and its radiated sound [HTN-95-51645] p 431 A95-85027
- Practical formulation of a positively conservative scheme [HTN-95-51668] p 433 A95-85050
- Stationary premixed flames in spherical and cylindrical geometries p 418 A95-86165
- Supersonic coaxial jet noise predictions [NASA-TM-106917] p 451 N95-26801
- The high speed civil transport and NASA's High Speed Research (HSR) program p 390 N95-26945
- Visualization of the multiple supersonic jet oscillations by swept focused strobed schlieren technique p 367 N95-26952
- NASA Lewis Research Center's combustor test facilities and capabilities [NASA-TM-106903] p 412 N95-27176
- Comparison of numerical results and multicavity purge and rim seal data with extensions to dynamics [NASA-TM-106685] p 416 N95-27434
- Further investigations of icing effects on an advanced high-lift multi-element airfoil [NASA-TM-106947] p 381 N95-27762
- Two-phase flow research using the learjet apparatus [NASA-TM-106814] p 438 N95-27854
- Optimization of wave rotors for use as gas turbine engine topping cycles [NASA-TM-106951] p 406 N95-27860
- Industry-Wide Workshop on Computational Turbulence Modeling [NASA-CP-10165] p 439 N95-27882
- Analysis of aircraft engine blade subject to ice impact p 407 N95-28277
- Numerical analysis of intra-cavity and power-stream flow interaction in multiple gas-turbine disk-cavities [NASA-TM-106886] p 407 N95-28344
- Probabilistic evaluation of fuselage-type composite structures p 398 N95-28444
- National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.**
- Dynamically timed electric motor [NASA-CASE-MFS-28958-1] p 437 N95-26890
- Bearing defect signature analysis using advanced nonlinear signal analysis in a controlled environment [NASA-TM-108491] p 441 N95-28364
- National Aerospace Lab., Tokyo (Japan).**
- Numerical simulation of combustion flow around a flame holder with hydrogen injection [NAL-TR-1233] p 419 N95-26523
- Experimental investigation of static and dynamic ground effect on HOPE ALFLEX vehicle [NAL-TR-1236] p 388 N95-26525
- Flight evaluation of GPS/DGPS sensor systems installed in NAL Do228 [NAL-TR-1230] p 382 N95-26585
- Experiment on a rectangular cross section scramjet combustor. 2: Effects of fuel injector geometry [NAL-TR-1220] p 405 N95-26600
- Effects of dust from storage heaters on ignition in scramjets [NAL-TR-1234] p 405 N95-26706

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- STEP: A future vision, today [NONP-NASA-VT-95-49121] p 452 N95-27209
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- A comparison of measured wind park load histories with the WISPER and WISPERX load spectra [DE95-000295] p 446 N95-27459
- Wind-tunnel test of the S814 thick root airfoil [DE95-000268] p 376 N95-27541
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- Bonded composite repair of thin metallic materials: Variable load amplitude and temperature cycling effects p 393 N95-27509
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- Naval Air Development Center, Warminster, PA.**
- Benefits and limitations of composites in carrier-based aircraft p 422 N95-28422
- Navy composite maintenance and repair experience p 424 N95-28446
- Naval Air Systems Command, Arlington, VA.**
- Naval Aviation System TEAM mapping, charting, and geodesy handbook [AD-A288590] p 446 N95-26841
- Naval Air Warfare Center, Warminster, PA.**
- An evaluation of the Software Through Pictures/T Tool (SIP/T) for the Software Support Activity (SSA) [AD-A288822] p 447 N95-26348
- Field repair materials for naval aircraft p 394 N95-27514
- Naval Postgraduate School, Monterey, CA.**
- Design and synthesis of a real-time controller for an unmanned air vehicle [AD-A289134] p 408 N95-26555
- Comparison of fixed wing aircraft algorithms for JANUS [AD-A288503] p 389 N95-26652
- Air cushioned landing craft (LCAC) based ship to shore movement simulation: A decision aid for the amphibious commander. A (SMMAT) application [AD-A289635] p 436 N95-26722
- A mathematical analysis of the Janus combat simulation weather effects models and sensitivity analysis of sky-to-ground brightness ratio on target detection [AD-A289629] p 446 N95-26858
- Construction and wind tunnel test of a 1/12th scale helicopter model [AD-A288487] p 378 N95-28331
- Proof test methodology for composites p 424 N95-28445
- Modeling helicopter blade dynamics using a modified Myklestad-Prohl transfer matrix method [AD-A289891] p 400 N95-28626
- Naval Research Lab., Washington, DC.**
- Speech analysis and synthesis based on pitch-synchronous segmentation of the speech waveform [AD-A288824] p 435 N95-26349
- Naval Surface Warfare Center, Dahlgren, VA.**
- Parallel block implicit integration technique for trajectory parallelism [AD-A288961] p 450 N95-28335
- Naval Weapons Center, China Lake, CA.**
- Composite flight-control actuator development p 410 N95-28281
- Nevada Univ., Reno, NV.**
- Application of CFD to the analysis and design of high-speed inlets [NASA-CR-198574] p 438 N95-27240
- New Mexico State Univ., Las Cruces, NM.**
- Demonstration study of hierarchical control of fluid-dynamic phenomena [AD-A289341] p 437 N95-26751
- New York Univ., New York, NY.**
- Computational fluid dynamics and transonic flow [AD-A288962] p 436 N95-26405
- Northrop Corp., Hawthorne, CA.**
- Analysis of composite structures with delaminations under combined bending and compression p 422 N95-28429
- C-130 Advanced Technology Center wing box conceptual design/cost study p 423 N95-28437
- Reliability analysis of composite structures p 423 N95-28441
- Northrop Grumman Corp., Hawthorne, CA.**
- Repair technology for thermoplastic aircraft structures p 395 N95-27519

- Notre Dame Univ., IN.**
- Effects of three-dimensional imposed 3-D disturbances on bluff-body near wake flows [AD-A289553] p 374 N95-26757
- O**
- Ohio State Univ., Columbus, OH.**
- Comparative wind tunnel test at high Reynolds numbers of NACA 64 621 airfoils with two aileron configurations p 377 N95-27977
- Old Dominion Univ., Norfolk, VA.**
- Extension to the dynamic modeling of the large angle magnetic suspension test fixture [NASA-CR-197801] p 411 N95-26768
- Oregon State Univ., Corvallis, OR.**
- Preliminary analysis of dynamic stall effects on a 91-meter wind turbine rotor p 376 N95-27975
- Overset Methods, Inc., Los Altos, CA.**
- Global flowfield about the V-22 Tiltrotor Aircraft [NASA-CR-198603] p 375 N95-27248
- P**
- Paragon Pacific, Inc., El Segundo, CA.**
- Design of a real-time wind turbine simulator using a custom parallel architecture p 449 N95-27979
- Polish Academy of Sciences, Warsaw (Poland).**
- Photoacoustic chambers for studying solids and gases: Theory and practical examples [IFTR-39/1994] p 412 N95-26837
- Pratt and Whitney Aircraft Group, West Palm Beach, FL.**
- Composite intermediate case manufacturing scale-up for advanced engines p 406 N95-28275
- Purdue Univ., West Lafayette, IN.**
- WINCLR: A computer code for heat transfer and clearance calculation in a compressor [NASA-CR-195436] p 366 N95-26363
- R**
- Radian Corp., Austin, TX.**
- Community relations plan: Galena Airport and Camp ion Air Force Station, Alaska [AD-A286722] p 446 N95-27234
- Remtech, Inc., Huntsville, AL.**
- Rarefied gas effects on aerobraking/reentry vehicles with wakes [NASA-CR-196586] p 415 N95-27093
- Rockwell International Corp., Golden, CO.**
- Horizontal axis wind turbine post stall airfoil characteristics synthesisization p 376 N95-27974
- Rockwell International Science Center, Thousand Oaks, CA.**
- Fundamental concepts in the suppression of delamination buckling by stitching p 426 N95-28486
- Royal Australian Air Force, Amberley (Australia).**
- The development of an engineering standard for composite repairs p 396 N95-27528
- S**
- Sandia National Labs., Albuquerque, NM.**
- A NASTRAN-based computer program for structural dynamic analysis of Horizontal Axis Wind Turbines p 439 N95-27980
- Sikorsky Aircraft, Stratford, CT.**
- Static and fatigue testing of full-scale fuselage panels fabricated using a Therm-X(R) process p 420 N95-28270
- Simula, Inc., Phoenix, AZ.**
- Rotorcraft crashworthy airframe and fuel system technology development program [AD-A289986] p 382 N95-28630
- Southwest Research Inst., San Antonio, TX.**
- Mechanism of deposit formation on fuel-wetted hot metal surfaces [AD-A289847] p 426 N95-28621
- Stanford Univ., CA.**
- Compressive strength of damaged and repaired composite plates p 442 N95-28484
- Strathclyde Univ., Glasgow (Scotland).**
- SMART materials: Surfaces, transforms and interfaces. The commensurate engineering dimension [AD-A289598] p 442 N95-28649
- Syracuse Univ., NY.**
- The noise reduction potential of dual-stream coaxial rectangular improperly expanded jet flows [NASA-CR-197820] p 437 N95-26995

T

Technion Research and Development Foundation Ltd., Haifa (Israel).

Advanced interactive display formats for terminal area traffic control
[NASA-CR-198576] p 384 N95-28188

Technische Univ., Delft (Netherlands).

Numerical simulation of crack growth in pressurized fuselages
[PB95-192415] p 400 N95-28636

Texas A&M Univ., College Station, TX.

Sailplane glide performance and control using fixed and articulating winglets
[NASA-CR-198579] p 392 N95-27180

Texas Univ., San Antonio, TX.

Probabilistic material strength degradation model for Inconel 718 components subjected to high temperature, high-cycle and low-cycle mechanical fatigue, creep and thermal fatigue effects
[NASA-CR-197832] p 419 N95-27167

Textron Specialty Materials, Lowell, MA.

Status of bonded boron/epoxy doublers for military and commercial aircraft structures p 393 N95-27506

Tokyo Univ., Sagami-hara (Japan).

Viscous shock-layer analysis on hypersonic flow over reentry capsule with nonequilibrium chemistry
[ISAS-656] p 436 N95-26739

Wind tunnel experiments on wake flow field behind a reentry capsule from a viewpoint of parachute deployment at supersonic speeds
[ISAS-655] p 374 N95-26740

Turkish Land Forces Command, Ankara (Turkey).

Scar joint technique with cocured and precured patches for composite repair p 396 N95-27524

U

United Technologies Research Center, East Hartford, CT.

Evaluation of a doubly-swept blade tip for rotorcraft noise reduction
[NASA-CR-189677] p 452 N95-28264

V

Veda, Inc., Dayton, OH.

Integrated mission precision attack cockpit technology (IMPACT). Phase 1: Identifying technologies for air-to-ground fighter integration
[AD-A289562] p 389 N95-26684

Virginia Polytechnic Inst., Blacksburg, VA.

Flow structure generated by perpendicular blade vortex interaction and implications for helicopter noise predictions
[NASA-CR-198590] p 377 N95-28193

Virginia Polytechnic Inst. and State Univ., Blacksburg, VA.

Load transfer in the stiffener-to-skin joints of a pressurized fuselage
[NASA-CR-198610] p 439 N95-27865
Vibrational behavior of adaptive aircraft wing structures modelled as composite thin-walled beams p 423 N95-28435

Vought Corp., Dallas, TX.

Repair of high temperature composite aircraft structure p 395 N95-27520

W

Wichita State Univ., Wichita, KS.

AIAA Techtest 20 Proceedings
[NIAR-94-1] p 367 N95-26941

An exploratory application of neural networks for airfoil design p 448 N95-26943

Creating an alternative parameter optimization method (APO) p 375 N95-26946

The near-wake flow behavior of an oscillating airfoil with modified trailing edge p 375 N95-26953

Full span flaperons for a biplane p 391 N95-26954

An experimental investigation of helicopter downwash and tailboom interaction at the Wichita State University 7x10 foot wind tunnel p 375 N95-26955

Comparative wind tunnel tests of NACA 23024 airfoils with several aileron and spoiler configurations p 376 N95-27976

Wright Lab., Wright-Patterson AFB, OH.

A non-iterative grid deformation algorithm for computational fluid dynamics for aeroelasticity
[AD-A288298] p 436 N95-26418

Partial discharge testing of high voltage wiring harness for airborne displays
[AD-A289150] p 401 N95-27003

Structural design optimization with survivability dependent constraints application: Primary wing box of a multi-role fighter p 398 N95-28440

Y

Yale Univ., New Haven, CT.

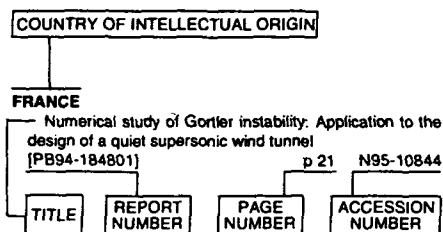
Transport phenomena and interfacial kinetics in multiphase combustion systems
[AD-A288297] p 418 N95-26417

FOREIGN TECHNOLOGY INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 321)

September 1995

Typical Foreign Technology Index Listing



Listings in this index are arranged alphabetically by country of intellectual origin. The title of the document is used to provide a brief description of the subject matter. The page number and accession number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document.

A

AUSTRALIA

- Subharmonic and quasi-periodic motions of an eccentric squeeze film damper-mounted rigid rotor
[BTN-94-EIX95011440601] p 429 A95-82982
- Effect of squeeze film damper land geometry on damper performance
[HTN-95-92247] p 434 A95-85291
- Design and development of a test rig for the high frequency testing of rolling sleeve airsprings
[DSTO-TN-0001] p 411 N95-26378
- F/A-18 IFOSTP Fatigue test airbag load determination on the vertical and horizontal tails
[DSTO-TR-0135] p 388 N95-26389
- Characteristics of the turbine inlet temperature sensing circuit for the T56 turbo-prop engine
[DSTO-TR-0095] p 405 N95-26424
- Bonded composite repair of metallic aircraft components: Overview of Australian activities
p 392 N95-27505
- Scarf repairs to graphite/epoxy components
p 396 N95-27523
- The development of an engineering standard for composite repairs
p 396 N95-27528
- A review of Australian and New Zealand investigations on aeronautical fatigue during the period Apr. 1993 - Mar. 1995
[AR-009-202] p 397 N95-27918
- Tie-down trials involving a Sikorsky S-70B-2 helicopter
[DSTO-TR-0132] p 400 N95-28567

C

CANADA

- Study of heat transfer rates during quenching of a hot tube under microgravity p 428 A95-82641
- Experimental investigation of flow-boiling heat transfer under microgravity p 428 A95-82642

- Fractal properties of whitecaps
[HTN-95-92121] p 443 A95-83827
- Evolution of the concentrations of trace species in an aircraft plume: Trajectory study
[HTN-95-A1044] p 443 A95-84549
- The effects of surface modification on fretting fatigue in Ti alloy turbine components
[HTN-95-61145] p 404 A95-84909
- Explicit Kutta condition for an unsteady two-dimensional constant potential panel method
[HTN-95-51679] p 433 A95-85061
- Compressible Navier-Stokes computations of multielement airfoil flows using multiblock grids
[HTN-95-42327] p 371 A95-86156
- Development of a large-aspect-ratio rectangular turbulent free jet
[HTN-95-42333] p 372 A95-86162
- Characterization of corrosion and development of a breadboard of a D sight aircraft inspection system, phase 1
[AD-A288347] p 380 N95-26527
- Bonded composite repair of thin metallic materials: Variable load amplitude and temperature cycling effects
p 393 N95-27509
- Design and structural validation of CF116 upper wing skin boron doubler
p 393 N95-27510
- Composite repair issues on the CF-18 aircraft
p 395 N95-27518

CHINA

- Numerical analysis of flow field around gas rudder
p 407 A95-82333
- Nonlinear observer and its application in flight control
p 447 A95-82449
- Study on a scheme for the prolongation of microgravity time of balloon-borne drop capsule
p 414 A95-82515
- An inverse design method of transonic airfoil and wing
[HTN-95-71128] p 385 A95-83489
- Nonlinear decoupling control study for aircraft maneuvering flight
[HTN-95-71130] p 408 A95-83491
- Non-linear viscoelastic-plastic constitutive relations for an aeronautical PMMA
[HTN-95-71132] p 385 A95-83493
- The analysis of the processing increased weight for pilot production of F-X aircraft
[HTN-95-71133] p 385 A95-83494
- Analysis of backscattering from wing and fuselage joints
[HTN-95-71134] p 430 A95-83495
- Numerical investigation to S-inlet flows (Numerical simulation study of S-inlet flows)
[AD-A289590] p 374 N95-26713
- Plate manipulators
[AD-A289601] p 374 N95-26719
- A numerical method for unsteady transonic flow about wings with control surfaces
[AD-A289631] p 375 N95-26859

F

FRANCE

- International cooperation in standardization
p 452 A95-82665
- Stochastic approach to noise modeling for free turbulent flows
[HTN-95-42321] p 371 A95-86150
- Airborne lidar observation of mountain-wave-induced polar stratospheric clouds during EASOE
[HTN-95-00738] p 444 A95-86308
- Composite Repair of Military Aircraft Structures
[AGARD-CP-550] p 392 N95-27504
- Composite repair of metallic airframe: Twenty years of experience
p 393 N95-27508
- Composite or metallic bolted repairs on self-stiffened carbon wing panel of the commuter ATR72 design criteria, analysis, verification by test
p 396 N95-27525

G

GERMANY

- Mapping of forest fire damages using imaging spectroscopy p 442 A95-83627
- A higher harmonic control test in the DNW to reduce impulsive BVI noise
[HTN-95-61071] p 385 A95-83655
- On the influence of time-varying flow velocity on unsteady aerodynamics
[HTN-95-61073] p 369 A95-83657
- Forming and bonding techniques for high-strength aluminum alloys
[HTN-95-20605] p 418 A95-84786
- Automatic riveting cell for commercial aircraft floor grid assembly
[HTN-95-92309] p 365 A95-85353
- Compressible inviscid vortex flow of a sharp edge delta wing
[BTN-95-EIX95262694308] p 370 A95-85479
- Aeroelastic stability of cascades in turbomachinery
[HTN-95-61156] p 405 A95-86255
- Aircraft measurements of CLO and HCL during EASOE 1991/92
[HTN-95-00721] p 444 A95-86291
- Two dimensional stratospheric aerosol distributions during EASOE
[HTN-95-00726] p 444 A95-86296
- Airborne measurements during the European Arctic Stratospheric Ozone Experiment column amounts of HNO3 and O3 derived from FTIR emission sounding
[HTN-95-00742] p 445 A95-86312
- Airborne measurements during the European Arctic Stratospheric Ozone Experiment: Observation of OCIO
[HTN-95-00745] p 445 A95-86315
- Airborne measurements during the Arctic stratospheric experiment: Observation of O3 and NO2
[HTN-95-00748] p 445 A95-86318
- On aircraft repair verification of a fighter A/C integrally stiffened fuselage skin
p 394 N95-27515
- Composite repair of a CF18: Vertical stabilizer leading edge
p 395 N95-27517
- External patch repair of CFRP/honeycomb sandwich
p 395 N95-27522
- Damage occurrence on composites during testing and fleet service: Repair of Airbus aircraft
p 396 N95-27526

I

INDIA

- Flow past a symmetric wedge with forward splitter plate
p 427 A95-82406
- Boundary layer studies over an S-blade
[HTN-95-92261] p 434 A95-85305
- Mobile domes for TACTIC telescope
p 453 A95-86113

ISRAEL

- Stress considerations in reduced-size aeroelastic optimization
[BTN-95-EIX95262694313] p 366 A95-85484
- Advanced interactive display formats for terminal area traffic control
[NASA-CR-198576] p 384 N95-28188
- Prediction of fatigue crack growth under constant amplitude and random loading using specimens with multiple cracks
[AD-A291614] p 397 N95-28409
- MATRIX fraction approach for finite-state aerodynamic modeling
[BTN-95-EIX95262694311] p 365 A95-85482

J

JAPAN

- Ignition analysis of hydrogen/air mixture in supersonic mixing layer
p 416 A95-82301
- Design features of the NAL ramjet engine test facility
p 410 A95-82319

FOREIGN

T

- Hypersonic wind tunnel test of sidewall compression type scramjet inlet p 410 A95-82320
 Evaluation of scramjet nozzle performance p 402 A95-82321
 An experimental investigation of scramjet nozzle flow p 402 A95-82322
 Prediction of pre-combustion shock in scramjet combustors: A new method p 402 A95-82323
 Experiment of rocket-ram annular combustor p 412 A95-82324
 An advanced scramjet propulsion concept for A 350 MG SSTO space plane p 402 A95-82325
 Test results on air turbo ramjet engine for a future space plane p 402 A95-82327
 Life evaluation of a low power arcjet thruster p 403 A95-82337
 R & D on HOPE structure p 413 A95-82355
 Research and development of thermal protection system of HOPE re-entry vehicle p 413 A95-82358
 Hypersonic trajectory control of aerospace plane with integrated SCRAMJET engine p 413 A95-82384
 Rarefied gas numerical wind tunnel: OREX and HOPE p 427 A95-82391
 VSL analysis of hypersonic flows around a reentry vehicle with equilibrium air chemistry p 413 A95-82400
 The aerodynamic characteristics of cup-like body in supersonic flow p 427 A95-82407
 Air data sensors for atmospheric reentry flight test of winged space vehicle p 413 A95-82412
 NAL aerothermodynamic probing and CFD verification mission in OREX experiment p 368 A95-82413
 Hypersonic thermal protection with mass injection at angle of attack p 414 A95-82414
 Numerical simulation of unsteady aerodynamic heating induced by shock reflections p 428 A95-82418
 A study on aerodynamic heating phenomena in three-dimensional shock wave/turbulent boundary layer interaction induced by sweptback sharp fins at supersonic flow p 428 A95-82419
 Experiment and analysis on heat transfer of a scramjet leading edge model p 403 A95-82420
 An experimental study on radiation from strong shock layer p 368 A95-82421
 Flight evaluation of DGPS and DGPS-INS navigation systems p 382 A95-82462
 A concept of a hypersonic flight experiment of a winged vehicle p 414 A95-82477
 A conceptual design of hypersonic research vehicle with subscale scramjet engine p 384 A95-82482
 Atmospheric reentry flight test of winged space vehicle p 414 A95-82483
 Reentry technology experiment on the first mission of reentry capsule 'EXPRESS' p 414 A95-82499
 Development and flight results of fiber reinforced balloon p 384 A95-82511
 Polar Patrol Balloon system and preliminary experimental results p 368 A95-82513
 How 'HITEN's' aerobraking experiments were carried out p 415 A95-82553
 Aero-thermodynamic flight environment at HITEN aerobrake experiment p 415 A95-82554
 Experimental investigation of composite channel heat pipe operation in micro-gravity environment p 428 A95-82645
 Hypersonic flow simulation with thermoelectric effect p 368 A95-82669
 Studies on gain performance of a combustion driven CO₂ gas dynamic laser p 428 A95-82679
 Studies on plasma jet igniters p 403 A95-82680
 Development of 70MW class superconducting generators [BTN-94-EIX95011440854] p 429 A95-82905
 Multiple instabilities of three-dimensional boundary layers along a concave wall [HTN-95-71126] p 429 A95-83487
 Observation of traveling waves in the three-dimensional boundary layer along a yawed cylinder [HTN-95-61064] p 430 A95-83648
 Instability of three-dimensional boundary layers due to streamline curvature p 430 A95-83654
 Study on the turbine vane and blade for a 1500 C class industrial gas turbine [BTN-94-EIX95011441254] p 431 A95-84211
 Air truth validation of cloud albedo estimated from NOAA advanced very high resolution radiometer data [HTN-95-A1021] p 443 A95-84526
 Numerical simulation of combustion flow around a flame holder with hydrogen injection [NAL-TR-1233] p 419 A95-26523
 Experimental investigation of static and dynamic ground effect on HOPE ALFLEX vehicle [NAL-TR-1236] p 388 A95-26525

- Flight evaluation of GPS/DGPS sensor systems installed in NAL Do228 [NAL-TR-1230] p 382 A95-26585
 Experiment on a rectangular cross section scramjet combustor. 2: Effects of fuel injector geometry [NAL-TR-1220] p 405 A95-26600
 Effects of dust from storage heaters on ignition in scramjets [NAL-TR-1234] p 405 A95-26706
 Viscous shock-layer analysis on hypersonic flow over reentry capsule with nonequilibrium chemistry [ISAS-656] p 436 A95-26739
 Wind tunnel experiments on wake flow field behind a reentry capsule from a viewpoint of parachute deployment at supersonic speeds [ISAS-655] p 374 A95-26740

K

KOREA, REPUBLIC OF

- Two-dimensional viscous flow past a flat plate [HTN-95-42210] p 430 A95-84026
 Prediction of two-dimensional momentumless wake by $k-\epsilon$ - γ model [BTN-95-EIX95262694299] p 434 A95-85470

N

NETHERLANDS

- Flight simulation fatigue crack growth testing of aluminum alloys [HTN-95-00652] p 418 A95-84731
 Fatigue of aircraft materials; Specialists' Conference, Delft, Netherlands, 1992 [HTN-95-B0076] p 387 A95-85892
 Status and prospects for aluminium-lithium alloys in aircraft structures p 387 A95-85893
 Fatigue of aircraft materials and structures p 387 A95-85894
 Fibre-Metal laminates p 387 A95-85895
 A review of the hot-wire technique in 2-D compressible flow [HTN-95-61157] p 373 A95-86256
 Numerical simulation of crack growth in pressurized fuselages [PB95-192415] p 400 A95-28636

P

POLAND

- Photoacoustic chambers for studying solids and gases: Theory and practical examples [IFTR-39/1994] p 412 A95-26837

R

ROMANIA

- Direct boundary integral equations method to subsonic flow with circulation past thin airfoils in ground effect [BTN-95-EIX95242673940] p 365 A95-82224
 Free convection past a uniform flux surface inclined at a small angle to the horizontal [HTN-95-42213] p 430 A95-84029

RUSSIA

- Stability of viscoelastic plate in supersonic flow under random loading [BTN-95-EIX95262694312] p 435 A95-85483
 JPRS report: Science and technology. Central Eurasia [JPRS-UST-94-022] p 438 A95-27699

S

SINGAPORE

- Scheduling of local nonlinear control laws by exogenous signals - an application to flight control [BTN-95-EIX95262694059] p 447 A95-85675

SOUTH AFRICA

- Differencing of density in compressible flow for a pressure-based approach [HTN-95-42349] p 373 A95-86178

SPAIN

- Repairs of CFC primary structures p 396 A95-27527

SWEDEN

- Verification of the damage tolerance of a fighter aircraft p 388 A95-85897

SWITZERLAND

- Data processing and mapping in airborne radiometric surveys [HTN-95-51587] p 442 A95-83591

TAIWAN, PROVINCE OF CHINA

- Transonic flutter suppression using active acoustic excitations [BTN-95-EIX95262694310] p 408 A95-85481
 High angle-of-attack airfoil performance improvement by internal acoustic excitation [HTN-95-42347] p 372 A95-86176

TURKEY

- Scarf joint technique with cocured and precured patches for composite repair p 396 A95-27524

U

UNITED KINGDOM

- Vibration measurements on rotating machinery using laser Doppler velocimetry [BTN-94-EIX95011440597] p 429 A95-82986
 The legal status and liability of the copilot, part 2 [HTN-95-A0578] p 452 A95-83158
 Considerations in the development of the coupled rotor fuselage model [HTN-95-61077] p 370 A95-83661
 The dynamic nature of rotor thermal bending due to unsteady lubricant shearing within a bearing [HTN-95-42091] p 430 A95-83857
 Control requirements for the RB 211 low-emission combustion system [BTN-94-EIX95011441244] p 416 A95-84201
 Computational analysis of buffet alleviation in viscous transonic flow over a porous airfoil [BTN-95-EIX95262694321] p 366 A95-85492
 An overview of the EASOE campaign [HTN-95-00702] p 443 A95-86272
 Adhesively bonded composite patch repair of cracked aluminum alloy structures p 393 A95-27507
 Composite repair of composite structures p 395 A95-27521
 SMART materials: Surfaces, transforms and interfaces. The commensurate engineering dimension [AD-A289598] p 442 A95-28649
- UNKNOWN**
- European firms team on supersonic studies [HTN-95-42215] p 386 A95-84031
 Maintenance programs [HTN-95-92310] p 365 A95-85354
 Aircraft stripping and painting [HTN-95-92311] p 365 A95-85355
 Condition monitoring and diagnostics [HTN-95-92312] p 387 A95-85356
 Artificial intelligence for turboprop engine maintenance [HTN-95-92313] p 404 A95-85357

V

VENEZUELA

- Contribution of thermal radiation to the temperature profile of ceramic composite materials [BTN-94-EIX95011441252] p 417 A95-84209

CONTRACT NUMBER INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 321)

September 1995

Typical Contract Number Index Listing

N00014-82-K-0185	p 22	N95-10231
CONTRACT NUMBER	PAGE NUMBER	ACCESSION NUMBER

Listings in this index are arranged alphanumerically by contract number. Under each contract number the accession numbers denoting documents that have been produced as a result of research done under the contract are shown. The accession number denotes the number by which the citation is identified in the abstract section. Preceding the accession number is the page number on which the citation may be found.

AF PROJ. 2308	p 418	N95-26417
AF PROJ. 2401	p 436	N95-26418
AF-AFOSR-0042-91	p 436	N95-26405
AF-AFOSR-0170-91	p 418	N95-26417
AF-AFOSR-89-0516	p 372	A95-86160
BMFT-01VOZ28A7	p 445	A95-86318
CDDF PROJ. 93-10	p 441	N95-28364
CEC-STEP-CT91-0140	p 445	A95-86312
	p 445	A95-86315
	p 445	A95-86318
CEC-STEP-CT91-040	p 444	A95-86308
DA PROJ. 1L1-62211-A-47-A	p 438	N95-27855
DA PROJ. 3M1-62787-A-879	p 391	N95-26993
DAAH04-93-G-0001	p 369	A95-83659
	p 369	A95-83660
DAAH04-94-6-0351	p 370	A95-83662
DAAK70-87-C-0043	p 426	N95-28621
DAAK70-82-C-0059	p 426	N95-28621
DAAL03-91-G-0308	p 400	N95-28504
DAAL03-93-G-002	p 370	A95-83662
DABT60-90-D-0010	p 391	N95-27018
DE-AC02-83CH-10093	p 451	N95-27991
DE-AC04-76DP-00789	p 439	N95-27980
DE-AC04-76DP-03533	p 376	N95-27974
DE-AC36-83CH-10093	p 446	N95-27459
	p 376	N95-27541
DE-A101-76ET-20320	p 447	N95-27970
DE-AR21-93MC-30358	p 392	N95-27440
DEN3-153	p 377	N95-27981
	p 440	N95-27982
	p 440	N95-27985
	p 440	N95-27986
DTFA01-93-C-00001	p 382	N95-26454
DTFA02-91-C-91089	p 384	N95-28540
DTFA03-83-A-00328	p 366	N95-26363
DTFA03-84-R-40032	p 382	N95-28630
DTFA03-89-C-00043	p 448	N95-26638
DTFA03-92-C-00003	p 380	N95-26497
EG-77-C-01-4042	p 451	N95-27991
F08635-89-C-0208	p 404	A95-86158
F09603-90-D-2217	p 367	N95-26629
F19628-90-C-0003	p 450	N95-28627
F29601-89-C-0089	p 449	N95-27246
F30602-89-D-0100	p 448	N95-26845
F33615-85-C-5152	p 406	N95-28275
F33615-90-D-4013	p 446	N95-27234
F33615-93-C-2321	p 407	N95-28646
F33615-93-D-3800	p 389	N95-26684
F33657-90-D-0027	p 423	N95-28437
F41624-93-C-2002	p 379	A95-84560
F49620-88-C-0076	p 432	A95-85030

F49620-92-J-0399	p 372	A95-86160
F49620-93-1-0579	p 397	N95-28409
F49620-94-C-0042	p 381	N95-27186
IRAD PROJ. R-1056	p 423	N95-28441
JPL-958123	p 447	N95-27805
MDA903-92-C-0047	p 386	A95-84558
MIPR-ARO-132-90	p 432	A95-85042
MIPR-91-0007	p 432	A95-85042
NAGW-2182	p 444	A95-86292
NAG1-1056	p 411	N95-26768
NAG1-1141	p 418	A95-85062
NAG1-1240	p 437	N95-26995
NAG1-1254	p 444	A95-86292
NAG1-1522	p 392	N95-27180
NAG1-1539	p 377	N95-28193
NAG1-373	p 432	A95-85028
NAG1-537	p 439	N95-27865
NAG1-795	p 432	A95-85028
NAG1-833	p 397	N95-28262
NAG2-663	p 445	N95-26669
NAG3-1072	p 377	N95-28003
NAG3-1242	p 418	A95-86165
NAG3-1523	p 418	A95-86165
NAG3-330	p 377	N95-27977
NAG3-378	p 451	N95-27992
NAG3-481	p 366	N95-26363
NAG3-867	p 419	N95-27167
NAG3-965	p 418	A95-86165
NAG5-2058	p 447	N95-27805
NASA ORDER L-40679-D	p 449	N95-27246
NAS1-18471	p 432	A95-85028
NAS1-18754	p 423	N95-28436
NAS1-18758	p 422	N95-28426
NAS1-18778	p 442	N95-28484
NAS1-18799	p 420	N95-28270
NAS1-18888	p 399	N95-28476
NAS1-18889	p 398	N95-28471
	p 398	N95-28473
	p 399	N95-28474
	p 426	N95-28478
	p 399	N95-28482
	p 392	N95-27371
NAS1-19000	p 452	N95-28073
NAS1-19060	p 432	A95-85029
NAS1-19061	p 452	N95-28264
NAS1-19143	p 406	N95-28227
NAS1-19462	p 438	N95-27179
NAS1-19480	p 442	N95-28673
	p 371	A95-86157
NAS1-19672	p 452	N95-28670
NAS1-20090	p 404	A95-86159
NAS1-795	p 381	N95-27859
NAS10-11624	p 377	N95-28230
NAS2-12513	p 378	N95-28265
	p 392	N95-27143
NAS2-5364	p 447	N95-27970
NAS3-25776	p 406	N95-27866
NAS3-25950	p 441	N95-27999
NAS3-25965	p 381	N95-27762
NAS3-27186	p 406	N95-27860
	p 415	N95-27093
NAS8-39368	p 437	N95-26890
NAS8-50000	p 384	N95-28188
NCCW-0045	p 374	N95-26760
NCC2-498	p 373	N95-26649
NCC2-505	p 438	N95-27240
NCC2-507	p 448	N95-26648
NCC2-522	p 433	A95-85050
NCC2-605	p 411	N95-26775
NCC2-616	p 389	N95-26651
NCC2-617	p 390	N95-26813
	p 436	N95-26589
NCC2-636	p 389	N95-26591
NCC2-657	p 401	N95-28203
NCC2-675	p 374	N95-26735
NCC2-729	p 389	N95-26590
NCC2-740	p 375	N95-27248
NCC2-747	p 406	N95-26777
NCC2-767	p 373	N95-26649
NCC2-796	p 439	N95-27882
NCC3-233	p 444	A95-86292
NSF ATM-84-19733	p 454	N95-28038
NSF ECS-89-02528	p 454	N95-28038
NSF ECS-89-22947	p 454	N95-28038

NSF ENG-91-11333	p 454	N95-28038
NSF ENG-92-17849	p 454	N95-28038
NSG-3277	p 376	N95-27976
N00014-88-C-0721	p 423	N95-28435
N00014-89-J-1361	p 437	N95-26998
N00014-89-J-3018	p 437	N95-26751
N00014-90-J-4083	p 374	N95-26757
N0014-94-J-9030	p 442	N95-28649
N60530-88-C-0260	p 410	N95-28281
N62269-87-C-0216	p 423	N95-28438
N62269-90-C-0282	p 422	N95-28429
N62269-90-C-0412	p 447	N95-26348
RTOP 232-01-02	p 416	N95-27434
RTOP 233-01-01-03	p 392	N95-27371
RTOP 233-01-03-23	p 449	N95-27246
RTOP 242-50-01	p 407	N95-28344
RTOP 335-05-01	p 377	N95-28003
RTOP 505-59-10-30	p 373	N95-26382
	p 378	N95-28669
	p 383	N95-26587
	p 367	N95-26710
	p 409	N95-26773
	p 376	N95-27258
RTOP 505-59-53-01	p 378	N95-28674
RTOP 505-59-53	p 449	N95-27914
RTOP 505-61-21	p 377	N95-28230
	p 378	N95-28265
RTOP 505-62-36	p 438	N95-27855
RTOP 505-62-52	p 366	N95-26363
	p 451	N95-26801
RTOP 505-62-82	p 412	N95-27176
RTOP 505-63-36-06	p 397	N95-28262
RTOP 505-63-50-13	p 366	N95-26381
RTOP 505-63-70-02	p 452	N95-28073
RTOP 505-64-52-01	p 410	N95-27839
RTOP 505-68-10	p 381	N95-27762
RTOP 505-68-32	p 405	N95-26412
RTOP 505-68-70-06	p 406	N95-28227
RTOP 505-68-70-09	p 378	N95-28241
RTOP 505-70-62-01	p 407	N95-28343
RTOP 505-90-21	p 377	N95-28003
RTOP 505-90-5K	p 439	N95-27882
RTOP 505-90-52-01	p 438	N95-27179
	p 442	N95-28673
RTOP 505-90-53-02	p 449	N95-27241
RTOP 505-90-58	p 406	N95-27860
RTOP 532-06-37-01	p 451	N95-26392
RTOP 536-01-11	p 453	N95-27367
RTOP 537-09-21-05	p 453	N95-26427
RTOP 537-10-20	p 406	N95-27866
RTOP 538-03-15-01	p 452	N95-28670
RTOP 550-00-00	p 416	N95-27763
RTOP 776-33-41	p 447	N95-27970
RTOP 963-20-0C	p 438	N95-27854
SBIR-02.04-8581	p 415	N95-27093
W-7405-ENG-36	p 420	N95-27851
W-7405-ENG-48	p 441	N95-28029
	p 452	N95-28108
	p 441	N95-28139
W-7405-ENG-82	p 436	N95-26445

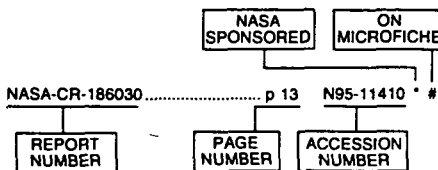
CONTRACT

REPORT NUMBER INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 321)

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Typical Report Number Index Listing



Listings in this index are arranged alphanumerically by report number. The page number indicates the page on which the citation is located. The accession number denotes the number by which the citation is identified. An asterisk (*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche.

A-90092 p 377 N95-28230 * #
A-90093 p 378 N95-28265 * #
A-94140 p 453 N95-27367 * #
A-950048 p 405 N95-26412 * #
A-950052 p 383 N95-26587 * #
A-950055 p 409 N95-26773 * #
A-950063 p 376 N95-27258 * #
A-95034 p 367 N95-26710 * #
A-95041 p 392 N95-27143 * #

AD-A280074 p 412 N95-28151
AD-A280075 p 420 N95-28152
AD-A286722 p 446 N95-27234 #
AD-A288280 p 445 N95-26453
AD-A288281 p 382 N95-26454
AD-A288284 p 366 N95-26455
AD-A288289 p 366 N95-26409
AD-A288297 p 418 N95-26417
AD-A288298 p 436 N95-26418
AD-A288347 p 380 N95-26527
AD-A288348 p 367 N95-26629
AD-A288401 p 380 N95-26497
AD-A288487 p 378 N95-28331
AD-A288492 p 448 N95-26838
AD-A288503 p 389 N95-26652
AD-A288536 p 381 N95-27186
AD-A288590 p 446 N95-26841
AD-A288610 p 388 N95-26481
AD-A288652 p 380 N95-26485
AD-A288744 p 401 N95-28586
AD-A288822 p 447 N95-26348
AD-A288824 p 435 N95-26349
AD-A288961 p 450 N95-28335
AD-A288962 p 436 N95-26405
AD-A289015 p 384 N95-27903
AD-A289134 p 408 N95-26555
AD-A289145 p 437 N95-26998
AD-A289150 p 401 N95-27003
AD-A289174 p 411 N95-26556
AD-A289190 p 391 N95-27018
AD-A289215 p 449 N95-26990
AD-A289220 p 409 N95-26957
AD-A289221 p 409 N95-26958
AD-A289246 p 412 N95-26966
AD-A289263 p 383 N95-26978
AD-A289271 p 409 N95-26981
AD-A289280 p 383 N95-26985
AD-A289288 p 410 N95-27036
AD-A289301 p 391 N95-27042
AD-A289306 p 448 N95-26920
AD-A289325 p 448 N95-26895
AD-A289328 p 383 N95-26898
AD-A289334 p 375 N95-26901
AD-A289336 p 419 N95-26842
AD-A289341 p 437 N95-26751

AD-A289376 p 390 N95-26876
AD-A289378 p 437 N95-26877
AD-A289379 p 406 N95-26878
AD-A289457 p 391 N95-26993
AD-A289458 p 391 N95-26994
AD-A289503 p 390 N95-26844
AD-A289508 p 375 N95-26854
AD-A289511 p 448 N95-26845
AD-A289540 p 390 N95-26873
AD-A289551 p 407 N95-26846
AD-A289553 p 374 N95-26757
AD-A289562 p 389 N95-26684
AD-A289590 p 374 N95-26713
AD-A289598 p 442 N95-26849
AD-A289601 p 374 N95-26719
AD-A289629 p 446 N95-26858
AD-A289631 p 375 N95-26859
AD-A289635 p 436 N95-26722
AD-A289771 p 410 N95-28598
AD-A289830 p 368 N95-26810
AD-A289847 p 426 N95-28621
AD-A289891 p 400 N95-28626
AD-A289912 p 450 N95-28627
AD-A289986 p 382 N95-28630
AD-A291614 p 397 N95-28409
AD-A291628 p 398 N95-28411
AD-A291666 p 381 N95-28454
AD-A291714 p 400 N95-28504

AD-D017251 p 389 N95-26537
AD-D017265 p 388 N95-26507

AFIT/CI/CIA/94-136 p 388 N95-26481
AFIT/CI/CIA/94-159 p 410 N95-28598

AFIT/GA/ENY/94D-1 p 412 N95-26966
AFIT/GA/ENY/94D-8 p 410 N95-27036

AFIT/GAE/ENY/94D-11 p 390 N95-26844
AFIT/GAE/ENY/94D-13 p 406 N95-26878
AFIT/GAE/ENY/94D-14 p 375 N95-26901
AFIT/GAE/ENY/94D-3 p 448 N95-26920

AFIT/GCS/ENC/94D-01 p 419 N95-26842
AFIT/GCS/ENG/94D-02 p 390 N95-26876
AFIT/GCS/ENG/94D-11 p 448 N95-26895

AFIT/GE/ENG/94D-04 p 449 N95-26990
AFIT/GE/ENG/94D-06 p 391 N95-27042
AFIT/GE/ENG/94D-07 p 437 N95-26877
AFIT/GE/ENG/94D-09 p 383 N95-26898
AFIT/GE/ENG/94D-13 p 383 N95-26985
AFIT/GE/ENG/94D-18 p 409 N95-26957
AFIT/GE/ENG/94D-24 p 409 N95-26958
AFIT/GE/ENG/94D-30 p 409 N95-26981

AFIT/GSO/ENS/94D-06 p 390 N95-26873

AFIT/GSS/LAR/94D-3 p 401 N95-28586

AFOSR-94-0687TR p 381 N95-27186
AFOSR-94-0691TR p 418 N95-26417
AFOSR-94-0760TR p 436 N95-26405

AGARD-CP-550 p 392 N95-27504 #

AIAA PAPER 95-1880 p 381 N95-27762 * #
AIAA PAPER 95-2681 p 412 N95-27176 * #
AIAA PAPER 95-3048 p 438 N95-27855 * #

AR-008-374 p 405 N95-26424
AR-008-418 p 400 N95-28567
AR-009-193 p 388 N95-26389
AR-009-201 p 411 N95-26378
AR-009-202 p 397 N95-27918

ARL-TR-723 p 438 N95-27855 * #

ARO-28493.1-EG p 400 N95-28504

ASC-TR-94-1022 p 375 N95-26854

B-256707 p 367 N95-26817 #
B-259389 p 397 N95-27910 #

BFLRF-290 p 426 N95-28621

BTN-94-EIX95011440597 p 429 A95-82986
BTN-94-EIX95011440601 p 429 A95-82982
BTN-94-EIX95011440854 p 429 A95-82905
BTN-94-EIX95011441063 p 429 A95-82798
BTN-94-EIX95011441236 p 431 A95-84193
BTN-94-EIX95011441238 p 370 A95-84195
BTN-94-EIX95011441239 p 403 A95-84196
BTN-94-EIX95011441240 p 403 A95-84197
BTN-94-EIX95011441241 p 431 A95-84198
BTN-94-EIX95011441244 p 416 A95-84201
BTN-94-EIX95011441245 p 417 A95-84202
BTN-94-EIX95011441246 p 417 A95-84203
BTN-94-EIX95011441250 p 431 A95-84207
BTN-94-EIX95011441252 p 417 A95-84209
BTN-94-EIX95011441254 p 431 A95-84211
BTN-94-EIX95011441256 p 417 A95-84213
BTN-95-EIX95122538875 p 408 A95-83000
BTN-95-EIX95242673665 p 427 A95-82259
BTN-95-EIX95242673673 p 450 A95-82251
BTN-95-EIX95242673940 p 365 A95-82224
BTN-95-EIX95242674338 p 450 A95-82176
BTN-95-EIX95262694059 p 447 A95-85675
BTN-95-EIX95262694295 p 434 A95-85466
BTN-95-EIX95262694297 p 365 A95-85468
BTN-95-EIX95262694298 p 434 A95-85469
BTN-95-EIX95262694299 p 434 A95-85470
BTN-95-EIX95262694303 p 435 A95-85474
BTN-95-EIX95262694306 p 411 A95-85477
BTN-95-EIX95262694308 p 370 A95-85479
BTN-95-EIX95262694309 p 370 A95-85480
BTN-95-EIX95262694310 p 408 A95-85481
BTN-95-EIX95262694311 p 365 A95-85482
BTN-95-EIX95262694312 p 435 A95-85483
BTN-95-EIX95262694313 p 366 A95-85484
BTN-95-EIX95262694314 p 435 A95-85485
BTN-95-EIX95262694320 p 387 A95-85491
BTN-95-EIX95262694321 p 366 A95-85492
BTN-95-EIX95262696644 p 435 A95-85519

CCMS-95-04 p 439 N95-27865 * #

CEAS/AIAA-95-171 p 451 N95-26801 * #

CMOTT-94-9 p 439 N95-27882 * #

CMU/SEI-94-TR-22 p 450 N95-28627 *

CONF-9411149-4 p 392 N95-27440 #
CONF-941118-3 p 436 N95-26445 #
CONF-950116-6 p 446 N95-27459 #
CONF-950116-7 p 376 N95-27541 #
CONF-950130-7 p 420 N95-27851 #
CONF-950256-1-REV-2 p 441 N95-28139 #
CONF-950256-1 p 441 N95-28029 #

DE94-014240 p 436 N95-26445 #
DE95-000268 p 376 N95-27541 #
DE95-000295 p 446 N95-27459 #
DE95-006347 p 420 N95-27851 #
DE95-007566 p 392 N95-27440 #
DE95-007948 p 452 N95-28108 #
DE95-008053 p 441 N95-28029 #
DE95-008060 p 441 N95-28139 #

DOE/MC-30358/95/C0432 p 392 N95-27440 #

DOE/NASA/5776-2 p 447 N95-27970 * #

DOT/FAA/AM-95/15 p 384 N95-28540 #

DOT/FAA/AT-94/1 p 382 N95-26454

DOT/FAA/CT-TN93/35 p 384 N95-27903

DOT/FAA/CT-TN94-61 p 366 N95-26363 * #
DOT/FAA/CT-TN94/28 p 383 N95-26978

DOT/FAA/CT-TN94/36 p 445 N95-26453
DOT/FAA/CT-TN94/41 p 380 N95-26485

REPORT

DOT/FAA/CT-88/10-VOL-2	p 448	N95-26638	HTN-95-51647	p 432	A95-85029 *	MCAT-95-18	p 373	N95-26649 *
DOT/FAA/CT-91/7	p 382	N95-28630	HTN-95-51648	p 432	A95-85030 *	MCAT-95-7	p 390	N95-26813 *
DOT/FAA/CT-92-25-VOL-1	p 421	N95-28420 *	HTN-95-51660	p 432	A95-85042			
DOT/FAA/CT-92-25-VOL-2	p 424	N95-28462 *	HTN-95-51664	p 432	A95-85046	MDC-91K0418	p 441	N95-27999 *
DOT/FAA/CT-92-25-VOL-3	p 420	N95-28266 *	HTN-95-51666	p 433	A95-85048			
DOT/FAA/CT-94/56	p 380	N95-26527	HTN-95-51668	p 433	A95-85050 *	MTR-90W00179	p 382	N95-26454
DOT/FAA/CT-94/63	p 368	N95-28610	HTN-95-51669	p 433	A95-85051	MTR-94W000110	p 382	N95-26454
DOT/FAA/CT-94/74	p 380	N95-26497	HTN-95-51670	p 433	A95-85052			
			HTN-95-51678	p 404	A95-85060	NAIC-ID(RS)T-0918-92	p 374	N95-26719
DOT/FAA/PP-94-1	p 412	N95-28151	HTN-95-51679	p 433	A95-85061	NAIC-ID(RS)T-0920-92	p 375	N95-26859
			HTN-95-51680	p 418	A95-85062 *	NAIC-ID(RS)T-0922-92	p 374	N95-26713
DSTO-TN-0001	p 411	N95-26378	HTN-95-61064	p 430	A95-83648			
DSTO-TN-0002	p 397	N95-27918	HTN-95-61070	p 430	A95-83654	NAL-TR-1220	p 405	N95-26600 #
			HTN-95-61071	p 385	A95-83655 *	NAL-TR-1230	p 382	N95-26585 #
DSTO-TR-0095	p 405	N95-26424	HTN-95-61072	p 369	A95-83656	NAL-TR-1233	p 419	N95-26523 #
DSTO-TR-0132	p 400	N95-28567	HTN-95-61073	p 369	A95-83657	NAL-TR-1234	p 405	N95-26706 #
DSTO-TR-0135	p 388	N95-26389	HTN-95-61074	p 369	A95-83658	NAL-TR-1236	p 388	N95-26525 #
			HTN-95-61075	p 369	A95-83659			
E-7267	p 377	N95-28003 *	HTN-95-61076	p 369	A95-83660	NAS 1.15:106685	p 416	N95-27434 *
E-9039	p 416	N95-27434 *	HTN-95-61077	p 370	A95-83661	NAS 1.15:106814	p 438	N95-27854 *
E-9295	p 439	N95-27882 *	HTN-95-61078	p 370	A95-83662	NAS 1.15:106875	p 438	N95-27855 *
E-9340	p 438	N95-27854 *	HTN-95-61120	p 415	A95-84884 *	NAS 1.15:106886	p 407	N95-28344 *
E-9439	p 447	N95-27970 *	HTN-95-61145	p 404	A95-84909	NAS 1.15:106903	p 412	N95-27176 *
E-9461	p 366	N95-26363 *	HTN-95-61156	p 405	A95-86255	NAS 1.15:106917	p 451	N95-26801 *
E-9498	p 438	N95-27855 *	HTN-95-61157	p 373	A95-86256	NAS 1.15:106947	p 381	N95-27762 *
E-9523	p 407	N95-28344 *	HTN-95-71126	p 429	A95-83487	NAS 1.15:106951	p 406	N95-27860 *
E-9584	p 451	N95-26801 *	HTN-95-71128	p 385	A95-83489	NAS 1.15:108491	p 441	N95-28364 *
E-9599	p 412	N95-27176 *	HTN-95-71130	p 408	A95-83491	NAS 1.15:108574	p 453	N95-28002 *
E-9653	p 406	N95-27866 *	HTN-95-71132	p 385	A95-83493	NAS 1.15:108863	p 367	N95-26710 *
E-9683	p 381	N95-27762 *	HTN-95-71133	p 385	A95-83494	NAS 1.15:108866	p 405	N95-26412 *
E-9689	p 406	N95-27860 *	HTN-95-71134	p 430	A95-83495	NAS 1.15:109168	p 366	N95-26381 *
			HTN-95-81498	p 386	A95-85212	NAS 1.15:109184	p 449	N95-27241 *
EDR-17199	p 406	N95-27866 *	HTN-95-81499	p 386	A95-85213	NAS 1.15:110142	p 381	N95-27859 *
			HTN-95-92121	p 443	A95-83827	NAS 1.15:110161	p 410	N95-27839 *
EOARD-TR-95-06	p 397	N95-28409	HTN-95-92246	p 433	A95-85290	NAS 1.15:110348	p 383	N95-26587 *
			HTN-95-92247	p 434	A95-85291	NAS 1.15:110349	p 409	N95-26773 *
ESC-TR-94-022	p 450	N95-28627 *	HTN-95-92255	p 434	A95-85299	NAS 1.15:110352	p 376	N95-27258 *
			HTN-95-92261	p 434	A95-85305	NAS 1.15:110608	p 451	N95-27908 *
FAA-AOR-100-94-009	p 380	N95-26485	HTN-95-92309	p 365	A95-85353	NAS 1.15:4611	p 378	N95-28241 *
			HTN-95-92310	p 365	A95-85354	NAS 1.15:4631	p 449	N95-27914 *
GAO/NSIAD-94-140	p 367	N95-26817 #	HTN-95-92311	p 365	A95-85355	NAS 1.15:83199-PT-4	p 451	N95-26392 *
GAO/NSIAD-95-112	p 397	N95-27910 #	HTN-95-92312	p 387	A95-85356	NAS 1.21:7037(318)	p 367	N95-27543 *
			HTN-95-92313	p 404	A95-85357	NAS 1.26:189077	p 441	N95-27999 *
H-1972	p 449	N95-27914 *				NAS 1.26:189677	p 452	N95-28264 *
			ICASE-95-39	p 438	N95-27179 *	NAS 1.26:189705-VOL-2	p 452	N95-28073 *
HTN-95-A0578	p 452	A95-83158	ICASE-95-41	p 442	N95-28673 *	NAS 1.26:189714	p 406	N95-28227 *
HTN-95-A1021	p 443	A95-84526				NAS 1.26:195077	p 452	N95-28670 *
HTN-95-A1038	p 443	A95-84543 *	ICOMP-94-30	p 439	N95-27882 *	NAS 1.26:195432	p 447	N95-27970 *
HTN-95-A1044	p 443	A95-84549				NAS 1.26:195436	p 366	N95-26363 *
HTN-95-A1048	p 417	A95-84553 *	IDA-P-2982	p 411	N95-26556	NAS 1.26:195469	p 406	N95-27866 *
HTN-95-B0076	p 387	A95-85892				NAS 1.26:196586	p 415	N95-27093 *
HTN-95-00652	p 418	A95-84731	IDA/HQ-94-45529	p 411	N95-26556	NAS 1.26:196694	p 392	N95-27143 *
HTN-95-00702	p 443	A95-86272				NAS 1.26:197744	p 389	N95-26651 *
HTN-95-00721	p 444	A95-86291	IFTR-39/1994	p 412	N95-26837	NAS 1.26:197745	p 390	N95-26813 *
HTN-95-00722	p 444	A95-86292 *				NAS 1.26:197747	p 374	N95-26760 *
HTN-95-00726	p 444	A95-86296	IS-M-790	p 436	N95-26445 #	NAS 1.26:197748	p 373	N95-26649 *
HTN-95-00738	p 444	A95-86308				NAS 1.26:197749	p 406	N95-26777 *
HTN-95-00742	p 445	A95-86312	ISAS-655	p 374	N95-26740 #	NAS 1.26:197750	p 411	N95-26775 *
HTN-95-00745	p 445	A95-86315	ISAS-656	p 436	N95-26739 #	NAS 1.26:197752	p 448	N95-26648 *
HTN-95-00748	p 445	A95-86318				NAS 1.26:197754	p 389	N95-26591 *
HTN-95-11909	p 404	A95-85990	ISBN 1-56091-428-9	p 417	A95-84553 *	NAS 1.26:197755	p 374	N95-26735 *
HTN-95-20602	p 443	A95-84783				NAS 1.26:197756	p 389	N95-26590 *
HTN-95-20603	p 404	A95-84784	ISBN-0-309-05045-6	p 381	N95-27907 #	NAS 1.26:197757	p 436	N95-26589 *
HTN-95-20605	p 418	A95-84786	ISBN-0-309-05183-5	p 446	N95-27156	NAS 1.26:197785	p 445	N95-26669 *
HTN-95-20713	p 435	A95-86603	ISBN-1-883-71231-9	p 454	N95-28038 *	NAS 1.26:197801	p 411	N95-26768 *
HTN-95-20731	p 435	A95-86621	ISBN-90-9007413-9	p 400	N95-28636 #	NAS 1.26:197820	p 437	N95-26995 *
HTN-95-42091	p 430	A95-83857	ISBN-92-836-0010-X	p 392	N95-27504 #	NAS 1.26:197832	p 419	N95-27167 *
HTN-95-42210	p 430	A95-84026				NAS 1.26:198162	p 438	N95-27179 *
HTN-95-42213	p 430	A95-84029	JPRS-UST-94-022	p 438	N95-27699 #	NAS 1.26:198164	p 442	N95-28673 *
HTN-95-42215	p 386	A95-84031				NAS 1.26:198165	p 449	N95-27246 *
HTN-95-42269	p 380	A95-84963	L-16700-PT-4	p 451	N95-26392 *	NAS 1.26:198563	p 454	N95-28038 *
HTN-95-42298	p 418	A95-84992	L-17360	p 373	N95-26382 *	NAS 1.26:198574	p 438	N95-27240 *
HTN-95-42308	p 450	A95-85002	L-17368	p 378	N95-28669 *	NAS 1.26:198576	p 384	N95-28188 *
HTN-95-42320	p 370	A95-86149 *	L-17388	p 378	N95-28241 *	NAS 1.26:198579	p 392	N95-27180 *
HTN-95-42321	p 371	A95-86150	L-17401	p 378	N95-28674 *	NAS 1.26:198590	p 377	N95-28193 *
HTN-95-42322	p 371	A95-86151	L-17422	p 407	N95-28343 *	NAS 1.26:198603	p 375	N95-27248 *
HTN-95-42324	p 371	A95-86153 *	L-17450	p 453	N95-26427 *	NAS 1.26:198609	p 401	N95-28203 *
HTN-95-42327	p 371	A95-86156				NAS 1.26:198610	p 439	N95-27865 *
HTN-95-42328	p 371	A95-86157 *	LA-UR-95-42	p 420	N95-27851 #	NAS 1.26:198621	p 447	N95-27805 *
HTN-95-42329	p 404	A95-86158				NAS 1.26:198718	p 420	N95-28266 *
HTN-95-42330	p 404	A95-86159 *	LC-94-65759	p 381	N95-27907 #	NAS 1.26:198722	p 424	N95-28462 *
HTN-95-42331	p 372	A95-86160	LC-94-68678	p 446	N95-27156	NAS 1.26:198723	p 421	N95-28420 *
HTN-95-42332	p 372	A95-86161				NAS 1.26:4348	p 378	N95-28265 *
HTN-95-42333	p 372	A95-86162	LT-94-1067	p 380	N95-26497	NAS 1.26:4349	p 377	N95-28230 *
HTN-95-42334	p 372	A95-86163				NAS 1.26:4496	p 377	N95-28003 *
HTN-95-42336	p 418	A95-86165 *	M/NAFA/94-1	p 366	N95-26363 *	NAS 1.26:4665	p 397	N95-28262 *
HTN-95-42337	p 405	A95-86166				NAS 1.26:4675	p 392	N95-27371 *
HTN-95-42338	p 372	A95-86167 *	MCAT-05-06	p 411	N95-26775 *	NAS 1.55:10165	p 439	N95-27882 *
HTN-95-42340	p 408	A95-86169	MCAT-95-01	p 374	N95-26760 *	NAS 1.55:3299	p 416	N95-27763 *
HTN-95-42347	p 372	A95-86176	MCAT-95-03	p 448	N95-26648 *	NAS 1.60:3496	p 378	N95-28674 *
HTN-95-42348	p 373	A95-86177	MCAT-95-07	p 389	N95-26651 *	NAS 1.60:3502	p 407	N95-28343 *
HTN-95-42349	p 373	A95-86178	MCAT-95-08	p 436	N95-26589 *	NAS 1.60:3515	p 378	N95-28669 *
HTN-95-42368	p 418	A95-86197	MCAT-95-11	p 389	N95-26591 *	NAS 1.60:3516	p 373	N95-26382 *
HTN-95-51587	p 442	A95-83591	MCAT-95-13	p 374	N95-26735 *	NAS 1.60:3524	p 453	N95-26427 *
HTN-95-51645	p 431	A95-85027 *	MCAT-95-14	p 389	N95-26590 *	NAS 1.61:1355	p 453	N95-27367 *
HTN-95-51646	p 432	A95-85028 *	MCAT-95-17	p 406	N95-26777 *	NAS 1.71:MFS-28958-1	p 437	N95-26890 *

REPORT NUMBER INDEX

WL-TR-95-2001

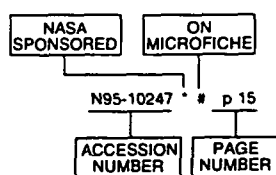
NASA-CASE-MFS-28958-1	p 437	N95-26890 * #	NREL/TP-442-7226	p 446	N95-27459 #
NASA-CP-10165	p 439	N95-27882 * #	NREL/TP-442-7388	p 376	N95-27541 #
NASA-CP-3299	p 416	N95-27763 * #	NRL/FR/5550-94-9743	p 435	N95-26349
NASA-CR-189077	p 441	N95-27999 * #	NSWCDD/TR-94/217	p 450	N95-28335
NASA-CR-189677	p 452	N95-28264 * #	NTSB/AAR-95/02	p 380	N95-26498 #
NASA-CR-189705-VOL-2	p 452	N95-28073 * #	OMI-01-92	p 375	N95-27248 * #
NASA-CR-189714	p 406	N95-28227 * #	PB94-155702	p 454	N95-28038 * #
NASA-CR-195077	p 452	N95-28670 * #	PB95-192415	p 400	N95-28636 #
NASA-CR-195432	p 447	N95-27970 * #	PB95-910402	p 380	N95-26498 #
NASA-CR-195436	p 366	N95-26363 * #	RAD-93-269-107-12-01	p 446	N95-27234 #
NASA-CR-195469	p 406	N95-27866 * #	REPT-95B00075	p 416	N95-27763 * #
NASA-CR-196586	p 415	N95-27093 * #	RL-TR-94-196	p 448	N95-26845
NASA-CR-196694	p 392	N95-27143 * #	RTR-249-01	p 415	N95-27093 * #
NASA-CR-197744	p 389	N95-26651 * #	SAE PAPER 930485	p 386	A95-84554
NASA-CR-197745	p 390	N95-26813 * #	SAE PAPER 932517	p 386	A95-84555
NASA-CR-197747	p 374	N95-26760 * #	SAE PAPER 932527	p 386	A95-84556
NASA-CR-197748	p 373	N95-26649 * #	SAE PAPER 932535	p 379	A95-84557
NASA-CR-197749	p 406	N95-26777 * #	SAE PAPER 932536	p 386	A95-84558
NASA-CR-197750	p 411	N95-26775 * #	SAE PAPER 932536	p 379	A95-84559
NASA-CR-197752	p 448	N95-26648 * #	SAE PAPER 932570	p 401	A95-84567
NASA-CR-197754	p 389	N95-26591 * #	SAE PAPER 932596	p 379	A95-84568
NASA-CR-197755	p 374	N95-26735 * #	SAE PAPER 932598	p 379	A95-84570
NASA-CR-197756	p 389	N95-26590 * #	SAE PAPER 932599	p 380	A95-84571
NASA-CR-197757	p 436	N95-26589 * #	SAE PAPER 932600	p 380	A95-84572
NASA-CR-197785	p 445	N95-26669 * #	SAE SP-992	p 417	A95-84553 *
NASA-CR-197801	p 411	N95-26768 * #	SBI-AD-E501-856	p 411	N95-26556
NASA-CR-197820	p 437	N95-26995 * #	TOP-7-3-534	p 391	N95-26994
NASA-CR-197832	p 419	N95-27167 * #	TR-524727	p 397	N95-28409
NASA-CR-198162	p 438	N95-27179 * #	TR-90425	p 382	N95-28630
NASA-CR-198164	p 442	N95-28673 * #	UCRL-ID-118981	p 452	N95-28108 #
NASA-CR-198165	p 449	N95-27246 * #	UCRL-JC-117918-REV-1	p 441	N95-28029 #
NASA-CR-198563	p 454	N95-28038 * #	UCRL-JC-117918-REV-2	p 441	N95-28139 #
NASA-CR-198574	p 438	N95-27240 * #	US-PATENT-APPL-SN-010986	p 389	N95-26537
NASA-CR-198576	p 384	N95-28188 * #	US-PATENT-APPL-SN-365880	p 437	N95-26890 * #
NASA-CR-198579	p 392	N95-27180 * #	US-PATENT-APPL-SN-839721	p 388	N95-26507
NASA-CR-198590	p 377	N95-28193 * #	US-PATENT-CLASS-244-1	p 388	N95-26507
NASA-CR-198603	p 375	N95-27248 * #	US-PATENT-5,340,054	p 388	N95-26507
NASA-CR-198609	p 401	N95-28203 * #	USAARL-95-4	p 391	N95-26993
NASA-CR-198610	p 439	N95-27865 * #	USAATCOM-TR-94-A-022	p 367	N95-26710 * #
NASA-CR-198621	p 447	N95-27805 * #	USAATCOM-TR-95-A-003	p 409	N95-26773 * #
NASA-CR-198718	p 420	N95-28266 * #	VPI-E-95-01	p 439	N95-27865 * #
NASA-CR-198722	p 424	N95-28462 * #	WL-TM-94-3130	p 436	N95-26418
NASA-CR-198723	p 421	N95-28420 * #	WL-TR-94-2099	p 401	N95-27003
NASA-CR-4348	p 378	N95-28265 * #	WL-TR-94-3143	p 389	N95-26684
NASA-CR-4349	p 377	N95-28230 * #	WL-TR-95-2001	p 407	N95-28646
NASA-CR-4496	p 377	N95-28003 * #			
NASA-CR-4665	p 397	N95-28262 * #			
NASA-CR-4675	p 392	N95-27371 * #			
NASA-RP-1355	p 453	N95-27367 * #			
NASA-SP-7037(318)	p 367	N95-27543 *			
NASA-TM-106685	p 416	N95-27434 * #			
NASA-TM-106814	p 438	N95-27854 * #			
NASA-TM-106875	p 438	N95-27855 * #			
NASA-TM-106886	p 407	N95-28344 * #			
NASA-TM-106903	p 412	N95-27176 * #			
NASA-TM-106917	p 451	N95-26801 * #			
NASA-TM-106947	p 381	N95-27762 * #			
NASA-TM-106951	p 406	N95-27860 * #			
NASA-TM-108491	p 441	N95-28364 * #			
NASA-TM-108574	p 453	N95-28002 * #			
NASA-TM-108863	p 367	N95-26710 * #			
NASA-TM-108866	p 405	N95-26412 * #			
NASA-TM-109168	p 366	N95-26381 * #			
NASA-TM-109184	p 449	N95-27241 * #			
NASA-TM-110142	p 381	N95-27859 * #			
NASA-TM-110161	p 410	N95-27839 * #			
NASA-TM-110348	p 383	N95-26587 * #			
NASA-TM-110349	p 409	N95-26773 * #			
NASA-TM-110352	p 376	N95-27258 * #			
NASA-TM-110608	p 451	N95-27908 * #			
NASA-TM-4611	p 378	N95-28241 * #			
NASA-TM-4631	p 449	N95-27914 * #			
NASA-TM-83199-PT-4	p 451	N95-26392 * #			
NASA-TP-3496	p 378	N95-28674 * #			
NASA-TP-3502	p 407	N95-28343 * #			
NASA-TP-3515	p 378	N95-28669 * #			
NASA-TP-3516	p 373	N95-26382 * #			
NASA-TP-3524	p 453	N95-26427 * #			
NATICK/TR-95/017	p 381	N95-28454			
NDU-ICAF-94-F2	p 366	N95-26409			
NDU-ICAF-94-F56	p 366	N95-26455			
NIAR-94-1	p 367	N95-26941 #			
NONP-NASA-DK-95-48301	p 383	N95-26587 * #			
NONP-NASA-VT-95-49121	p 452	N95-27209			

ACCESSION NUMBER INDEX

AERONAUTICAL ENGINEERING / A Continuing Bibliography (Supplement 321)

September 1995

Typical Accession Number Index Listing



Listings in this index are arranged alphanumerically by accession number. The page number indicates the page on which the citation is located. The accession number denotes the number by which the citation is identified. An asterisk (*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche.

A95-82176	p 450	A95-83489	p 385	A95-86312	p 445	N95-26901	p 375
A95-82224	p 365	A95-83491	p 408	A95-86315	p 445	N95-26920	p 448
A95-82251	p 450	A95-83493	p 385	A95-86318	p 445	N95-26941	# p 367
A95-82259	p 427	A95-83495	p 430	A95-86603	p 435	N95-26942	# p 390
A95-82301	p 416	A95-83521	p 442	A95-86621	p 435	N95-26943	# p 448
A95-82319	p 410	A95-83527	p 442			N95-26944	# p 412
A95-82320	p 410	A95-83648	p 430	N95-26348	p 447	N95-26945	# p 390
A95-82321	p 402	A95-83654	p 430	N95-26349	p 435	N95-26946	# p 375
A95-82322	p 402	A95-83655	p 385	N95-26363	* # p 366	N95-26947	# p 391
A95-82323	p 402	A95-83656	p 369	N95-26378	p 411	N95-26948	# p 367
A95-82324	p 412	A95-83657	p 369	N95-26381	* # p 366	N95-26949	# p 409
A95-82325	p 402	A95-83658	p 369	N95-26382	* # p 373	N95-26951	# p 412
A95-82327	p 402	A95-83659	p 369	N95-26389	# p 388	N95-26952	* # p 367
A95-82333	p 407	A95-83660	p 369	N95-26392	* # p 451	N95-26953	# p 375
A95-82337	p 403	A95-83661	p 370	N95-26405	p 436	N95-26954	# p 391
A95-82355	p 413	A95-83662	p 370	N95-26409	p 366	N95-26955	# p 375
A95-82358	p 413	A95-83827	p 443	N95-26412	* # p 405	N95-26956	* # p 391
A95-82384	p 413	A95-83857	p 430	N95-26417	p 418	N95-26957	# p 409
A95-82391	p 427	A95-84026	p 430	N95-26418	p 436	N95-26958	p 409
A95-82400	p 413	A95-84029	p 430	N95-26424	p 405	N95-26959	p 412
A95-82406	p 427	A95-84031	p 386	N95-26427	* # p 453	N95-26966	p 383
A95-82407	p 427	A95-84193	p 431	N95-26445	# p 436	N95-26978	p 409
A95-82412	p 413	A95-84195	p 370	N95-26453	p 445	N95-26981	p 383
A95-82413	p 368	A95-84196	p 403	N95-26454	p 382	N95-26985	p 449
A95-82414	p 414	A95-84197	p 403	N95-26455	p 366	N95-26990	p 391
A95-82418	p 428	A95-84198	p 431	N95-26481	p 388	N95-26993	p 391
A95-82419	p 428	A95-84201	p 416	N95-26485	p 380	N95-26994	# p 437
A95-82420	p 403	A95-84202	p 417	N95-26497	p 380	N95-26995	* # p 437
A95-82421	p 368	A95-84203	p 417	N95-26498	# p 380	N95-26998	p 401
A95-82449	p 447	A95-84207	p 431	N95-26507	# p 388	N95-27003	p 391
A95-82462	p 382	A95-84209	p 417	N95-26523	# p 419	N95-27018	p 410
A95-82477	p 414	A95-84211	p 431	N95-26525	# p 388	N95-27036	p 391
A95-82482	p 384	A95-84213	p 417	N95-26527	# p 380	N95-27042	p 415
A95-82483	p 414	A95-84526	p 443	N95-26537	p 389	N95-27093	* # p 392
A95-82499	p 414	A95-84543	p 443	N95-26555	p 408	N95-27143	* # p 446
A95-82511	p 384	A95-84549	p 443	N95-26556	p 411	N95-27156	* # p 419
A95-82512	p 385	A95-84553	p 417	N95-26558	# p 382	N95-27167	* # p 412
A95-82513	p 368	A95-84554	p 386	N95-26587	* # p 383	N95-27176	* # p 438
A95-82515	p 414	A95-84555	p 386	N95-26589	* # p 436	N95-27179	* # p 392
A95-82553	p 415	A95-84556	p 386	N95-26590	* # p 389	N95-27180	* # p 381
A95-82554	p 415	A95-84557	p 379	N95-26591	* # p 389	N95-27186	p 452
A95-82641	p 428	A95-84558	p 386	N95-26600	# p 405	N95-27209	# p 446
A95-82642	p 428	A95-84559	p 379	N95-26629	p 367	N95-27234	# p 438
A95-82645	p 428	A95-84560	p 379	N95-26638	p 448	N95-27240	* # p 449
A95-82665	p 452	A95-84567	p 401	N95-26648	* # p 448	N95-27241	* # p 449
A95-82669	p 368	A95-84568	p 379	N95-26649	* # p 373	N95-27246	* # p 449
A95-82679	p 428	A95-84570	p 379	N95-26651	* # p 389	N95-27248	* # p 375
A95-82680	p 403	A95-84571	p 380	N95-26652	p 389	N95-27258	* # p 376
A95-82798	p 429	A95-84572	p 380	N95-26669	* # p 445	N95-27354	* # p 438
A95-82905	p 429	A95-84731	p 418	N95-26684	p 389	N95-27367	* # p 453
A95-82982	p 429	A95-84783	p 443	N95-26706	# p 405	N95-27371	* # p 392
A95-82986	p 429	A95-84784	p 404	N95-26710	* # p 367	N95-27434	* # p 416
A95-83000	p 408	A95-84786	p 418	N95-26713	p 374	N95-27440	# p 392
A95-83158	p 452	A95-84884	* p 415	N95-26719	p 374	N95-27459	# p 446
A95-83487	p 429			N95-26722	p 436	N95-27504	# p 392
				N95-26735	* # p 374	N95-27505	# p 392
				N95-26739	# p 436	N95-27506	# p 393
				N95-26740	# p 374	N95-27507	# p 393
				N95-26751	p 437	N95-27508	# p 393
				N95-26757	p 374	N95-27509	# p 393
				N95-26760	* # p 374	N95-27510	# p 394
				N95-26768	* # p 411	N95-27511	# p 394
				N95-26773	* # p 409	N95-27512	# p 394
				N95-26775	* # p 411	N95-27513	# p 394
				N95-26777	* # p 406	N95-27514	# p 394
				N95-26801	* # p 451	N95-27515	# p 394
				N95-26813	* # p 390	N95-27516	# p 395
				N95-26817	# p 367	N95-27517	# p 395
				N95-26837	p 412	N95-27518	# p 395
				N95-26841	p 446	N95-27519	# p 395
				N95-26842	p 419	N95-27520	# p 395
				N95-26844	p 390	N95-27521	# p 395
				N95-26845	p 448	N95-27522	# p 395
				N95-26854	p 375	N95-27523	# p 396
				N95-26858	p 446	N95-27524	# p 396
				N95-26859	p 375	N95-27525	# p 396
				N95-26873	p 390	N95-27526	# p 396
				N95-26876	p 390	N95-27527	# p 396
				N95-26877	p 437	N95-27528	# p 396
				N95-26878	p 406	N95-27541	# p 376
				N95-26890	* # p 437	N95-27543	* # p 367
				N95-26895	p 448	N95-27656	* # p 419
				N95-26898	p 383	N95-27699	# p 438
						N95-27762	* # p 381

ACCESSION

N95-27763

N95-27763 * #	p 416	N95-28462 * #	p 424
N95-27791 * #	p 383	N95-28463 * #	p 424
N95-27805 * #	p 447	N95-28464 * #	p 424
N95-27839 * #	p 410	N95-28465 * #	p 453
N95-27851 * #	p 420	N95-28466 * #	p 425
N95-27854 * #	p 438	N95-28467 * #	p 441
N95-27855 * #	p 438	N95-28468 * #	p 441
N95-27859 * #	p 381	N95-28469 * #	p 425
N95-27860 * #	p 406	N95-28470 * #	p 398
N95-27865 * #	p 439	N95-28471 * #	p 398
N95-27866 * #	p 406	N95-28473 * #	p 398
N95-27882 * #	p 439	N95-28474 * #	p 399
N95-27885 * #	p 439	N95-28475 * #	p 425
N95-27886 * #	p 439	N95-28476 * #	p 399
N95-27889 * #	p 439	N95-28477 * #	p 425
N95-27903 * #	p 384	N95-28478 * #	p 426
N95-27907 * #	p 381	N95-28480 * #	p 399
N95-27908 * #	p 451	N95-28481 * #	p 426
N95-27910 * #	p 397	N95-28482 * #	p 399
N95-27914 * #	p 449	N95-28483 * #	p 426
N95-27918 * #	p 397	N95-28484 * #	p 442
N95-27970 * #	p 447	N95-28486 * #	p 426
N95-27974 * #	p 376	N95-28487 * #	p 399
N95-27975 * #	p 376	N95-28488 * #	p 400
N95-27976 * #	p 376	N95-28489 * #	p 400
N95-27977 * #	p 377	N95-28504 * #	p 400
N95-27978 * #	p 377	N95-28540 * #	p 384
N95-27979 * #	p 449	N95-28567 * #	p 400
N95-27980 * #	p 439	N95-28586 * #	p 401
N95-27981 * #	p 377	N95-28598 * #	p 410
N95-27982 * #	p 440	N95-28610 * #	p 368
N95-27983 * #	p 440	N95-28621 * #	p 426
N95-27985 * #	p 440	N95-28626 * #	p 400
N95-27986 * #	p 440	N95-28627 * #	p 450
N95-27989 * #	p 440	N95-28630 * #	p 382
N95-27990 * #	p 451	N95-28636 * #	p 400
N95-27991 * #	p 451	N95-28646 * #	p 407
N95-27992 * #	p 451	N95-28649 * #	p 442
N95-27999 * #	p 441	N95-28669 * #	p 378
N95-28002 * #	p 453	N95-28670 * #	p 452
N95-28003 * #	p 377	N95-28673 * #	p 442
N95-28029 * #	p 441	N95-28674 * #	p 378
N95-28038 * #	p 454		
N95-28073 * #	p 452		
N95-28108 * #	p 452		
N95-28139 * #	p 441		
N95-28151 * #	p 412		
N95-28152 * #	p 420		
N95-28188 * #	p 384		
N95-28193 * #	p 377		
N95-28203 * #	p 401		
N95-28227 * #	p 406		
N95-28230 * #	p 377		
N95-28241 * #	p 378		
N95-28262 * #	p 397		
N95-28264 * #	p 452		
N95-28265 * #	p 378		
N95-28266 * #	p 420		
N95-28267 * #	p 420		
N95-28268 * #	p 420		
N95-28270 * #	p 420		
N95-28271 * #	p 420		
N95-28273 * #	p 421		
N95-28274 * #	p 421		
N95-28275 * #	p 406		
N95-28276 * #	p 421		
N95-28277 * #	p 407		
N95-28278 * #	p 397		
N95-28281 * #	p 410		
N95-28289 * #	p 421		
N95-28331 * #	p 378		
N95-28335 * #	p 450		
N95-28343 * #	p 407		
N95-28344 * #	p 407		
N95-28364 * #	p 441		
N95-28409 * #	p 397		
N95-28411 * #	p 398		
N95-28420 * #	p 421		
N95-28421 * #	p 421		
N95-28422 * #	p 422		
N95-28426 * #	p 422		
N95-28427 * #	p 422		
N95-28429 * #	p 422		
N95-28432 * #	p 422		
N95-28435 * #	p 423		
N95-28436 * #	p 423		
N95-28437 * #	p 423		
N95-28438 * #	p 423		
N95-28439 * #	p 423		
N95-28440 * #	p 398		
N95-28441 * #	p 423		
N95-28443 * #	p 424		
N95-28444 * #	p 398		
N95-28445 * #	p 424		
N95-28446 * #	p 424		
N95-28454 * #	p 381		

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